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Transactions of

THE HUDSON COAL COMPANY

Vol. 1 No. 4

12 Mar 26

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MECHANICAL MINING

By the Committee on Mechanical Mining

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MECHANICAL MINING

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INTRODUCTION

During the year 1917—77,062,787 tons of anthracite coal were produced of which 1,745,735 tons, or 2.3 percent., resulted from machine mine operations. As a contrast, in 1912 a tonnage of 64,667,249 was mined and in that year, only 0.34 percent. was mined by machines. The growth of production from 0.34 percent. to 2.3 percent. in five years is ample evidence of the importance of this subject. It would hardly be necessary to provide any further introduction, were it not for the fact that in the Anthracite Region the progress of machines has not been so rapid as in the Bituminous Fields of Pennsylvania where during 1917—172,448,142 tons of coal were produced, 95,423,140 tons or 55.3 percent. being machine mined, while 1912 had a production of 161,865,488 tons, of which machines produced 82,192,042, or 50.8 percent. Interest, therefore, in the whole question of machine mining does not rest so much on what has been accomplished in the past, as on what it is possible and necessary to do in the future.

Mining machines were originally designated for cutting in bituminous coal only. Anthracite on account of its hardness, was long neglected as too troublesome a problem, and it has only been during the past few years, comparatively speaking, that the manufacturers have turned their attention to the possibilities of the hard coal fields. The first machine to operate in anthracite was placed in the Butler Mine of the Hillside Coal & Iron Co., December 23, 1910, by the Sullivan Machinery Company. This cutter had not been specially designed to mine this class of coal, but even with that drawback, two thirty-foot chambers were cut five feet deep in three hours, demonstrating beyond a doubt that with heavier equipment and some minor changes in design, mining machines would work in hard coal. Growing from this very recent start, there are now about 90 mining machines in the Northern Coal Fields.

In the 100 years from 1761, over sixty patents were taken out for coal cutting machinery. In the most of them, some form of the miner's pick was used, but by degrees this primitive idea was departed from and other inventors used first, some form of circular saw or disk; second, chisels or bits attached to moving chains; third, cutting by impact. In all these devices the machine was to be driven by hand, water, steam or compressed air. It was not until years after, that electricity came to play its part in machine mining. To its advent and application is due the commencement of a real success in coal mining.

CHAPTER 1

MODERN COAL MINING MACHINES

Types of Coal Cutting Machines

In general, coal cutting machines can be divided into the following groups:

1. Percussive Machines
   - (a) Punchers
   - (b) Radial Percussive
2. Cutting Machines
   - (a) Bar
   - (b) Disc
   - (c) Chain

1. PERCUSSIVE MACHINES

Punchers

Machines of this type work practically in the same manner as the miner does with the pick. It is set on a platform, 3 to 4 feet wide, with a slight pitch toward the face, the operator holding his foot against the wheel to retard the recoil. Owing to the rapid vibration caused by the recoil, this machine is heavy on the operator. Fig. 1 shows the puncher type machine on its platform, the position of the operator, and his helper, who clears the cutting away from the machine.

Figure 1—Punching Machine in Actual Operation.

Radial Percussive Cutters

In this type the cylinder of the machine is mounted on an extension column, provided with a worm gear, wheel and ratchet around which the cylinder with pick attached, can be revolved through 360 degrees, as shown in Fig. 2. In operation, the cutter is set up in the center of the gangway or chamber and by using a series of lengthening steels, 12-in.—24-in.—36-in. to 8 feet, provided with five prong removable cutters, undercuts a square face giving a six to eight foot undercut about fifteen feet wide. While two cuts are therefore required for a 30-foot chamber, one will cut out a gangway in slightly over an hour. The machine is readily set up, can be carried around rapidly by two men; will undercut in any position in the vein, and can, therefore, be used to eliminate bands of useless material. A speed of cutting equal to 840 square feet in 8 hours has been attained with this type of cutter in soft coal 4 foot 6 inches high. This would be equal to four and one-half 30-foot chambers with a six foot undercut in eight hours. As the machine is air driven, its efficiency depends largely upon the air pressure maintained.

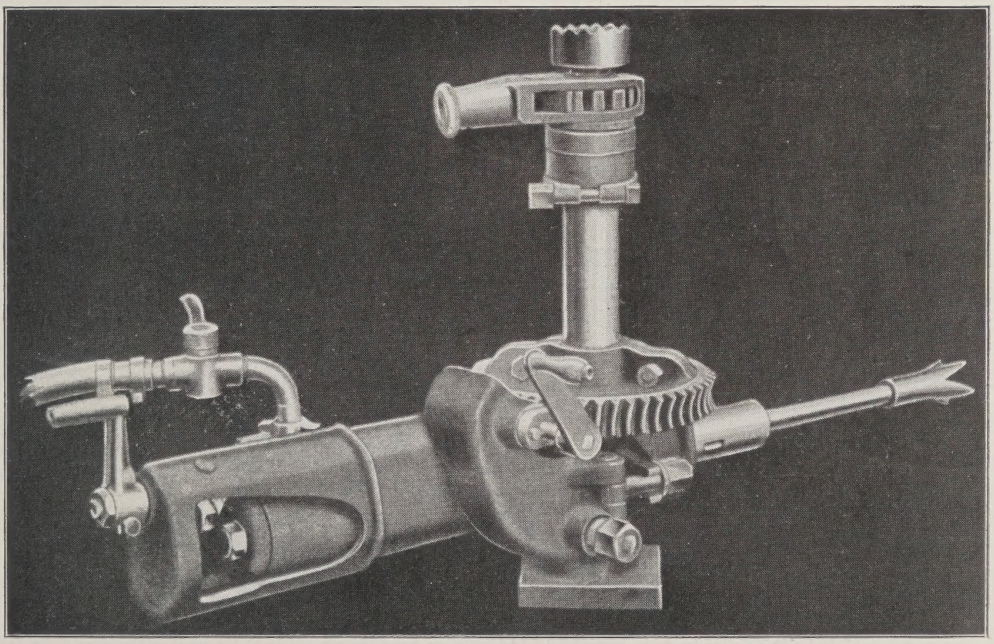


Figure 2—Radial Percussive Coal Cutter.

Disk Machines

The disk machine was designed for longwall work, and it is one of the heaviest and fastest cutters, cleaning out the kerf by its own action. In principle it is almost identical with a circular cut-off saw in a lumber mill, that is to say, the disk or circular saw is pulled or pushed into the material to be cut, and the cutting is done by means of bits or cutters inserted into the periphery of a wheel. Wheels of different diameters are used so as to undercut from three to six feet in the different sizes made. A disadvantage of this type is the liability of the wheel to get clogged or jammed by coal falling on the wheel or impurities in the bed, in the undercut.

Chain Machines

There are a large number of machines operating with a chain cutter, this class being the most universally used appliance in use to-day. The most important types are as follows:

1. Shearing Machine
2. Chain Breast Machine
3. Arc Wall Machines and Overcutters
4. Straight Face Machines
5. Short Wall or Continuous Coal Cutters
6. Longwall Machines.

Shearing Machine

Shearing is a method of obtaining faces of least resistance that is not practised in the anthracite region. The machine is held in position by three supports which are fastened to the bottom and the roof by extension screws. The machine makes a vertical cut from 5 to 7 feet deep and 3 feet at one setting. It is then raised or lowered by its own power to make another cut directly above or below the first. A truck carries it to the working face.

Chain Breast Machines

The introduction of the Chain Breast Machine was an important change for the better, over the first cutter bar machines. Fig. 3 shows one of the latest types of chain breast machines, electrically

driven. In some cases a compressed air motor is provided. The movable arm carrying the chain and the motor is fed forward at a speed of about one foot per minute, depending of course, upon the nature of the material cut, both ends of the machine being held in place by jacks. These jacks are attached to the machine and are screwed into the roof. The frame carrying the chain is triangular in form, and the front or cutting end of the triangle is three feet six inches long. The speed of the chain is from 250 to 275 feet per minute.

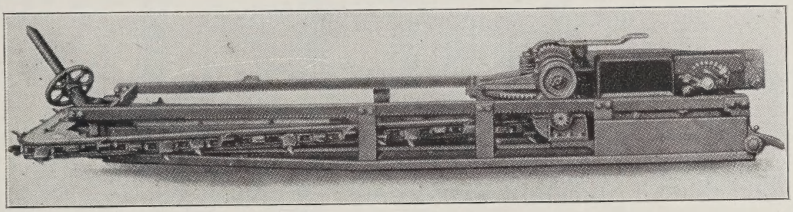


Figure 3—Latest Type of Chain Breast Machine.

In operation the machine is taken off the truck at the face and barred over to the right corner of the chamber or room. The cutting end is placed against the face, and the side of the machine is placed close against the rib. In this position the machine is securely jacked—the power turned on and the frame carrying the cutter chain is driven into the coal, making an undercut six feet deep and three feet six inches wide. When the cut is completed, the motor is reversed and the frame carrying the chain is withdrawn. The machine is then barred over three feet six inches and another cut made, this operation being repeated until all the face is undercut.

There are a number of objections to this type of machine. In the first place, props have been kept back from the face at least twelve feet, which is a dangerous practice unless the roof is very strong. It takes considerable time and labor shifting machinery for each cut. Unless care is used there will be blocks of coal remaining uncut, and on account of the length of time required to make the cuts, there is great danger of the frame being jammed by falling coal.

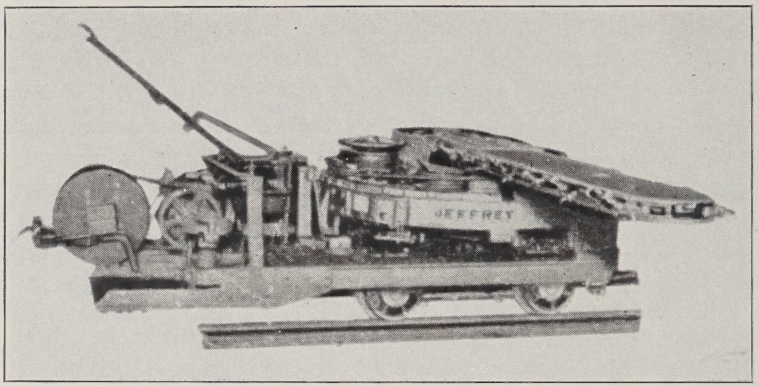


Figure 4—Arc Wall Mining Machine.

Arc Wall Machines and Overcutters

A comparatively new type of coal cutter is called "Arc Wall." The machine is shown in Fig. 4. As its name implies, the path of the undercut is an arc of a circle. The machine will cut from two feet to six feet above the floor, and is especially designed to cut out binders. It is self-propelling with a speed travel of 3½ miles per hour. No time is lost in loading or unloading the machine from truck, as it is self-contained and ready to make a cut the moment it reaches the face. The machine can be built to cut anywhere above the top of the rail, and it is adjustable while in operation, carries a seven foot bar with a twenty foot sweep, and may be used for cutting chambers or headings.

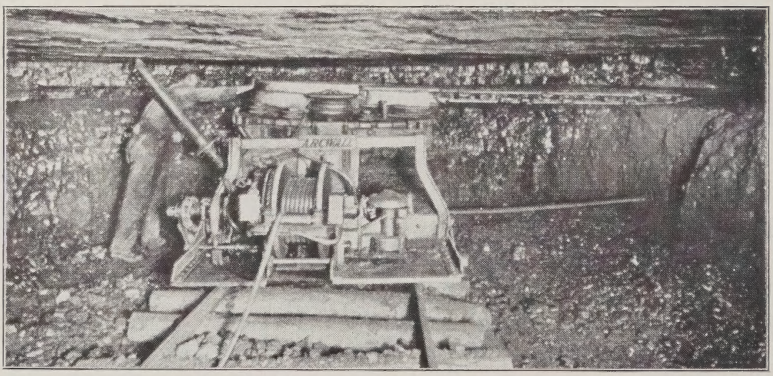
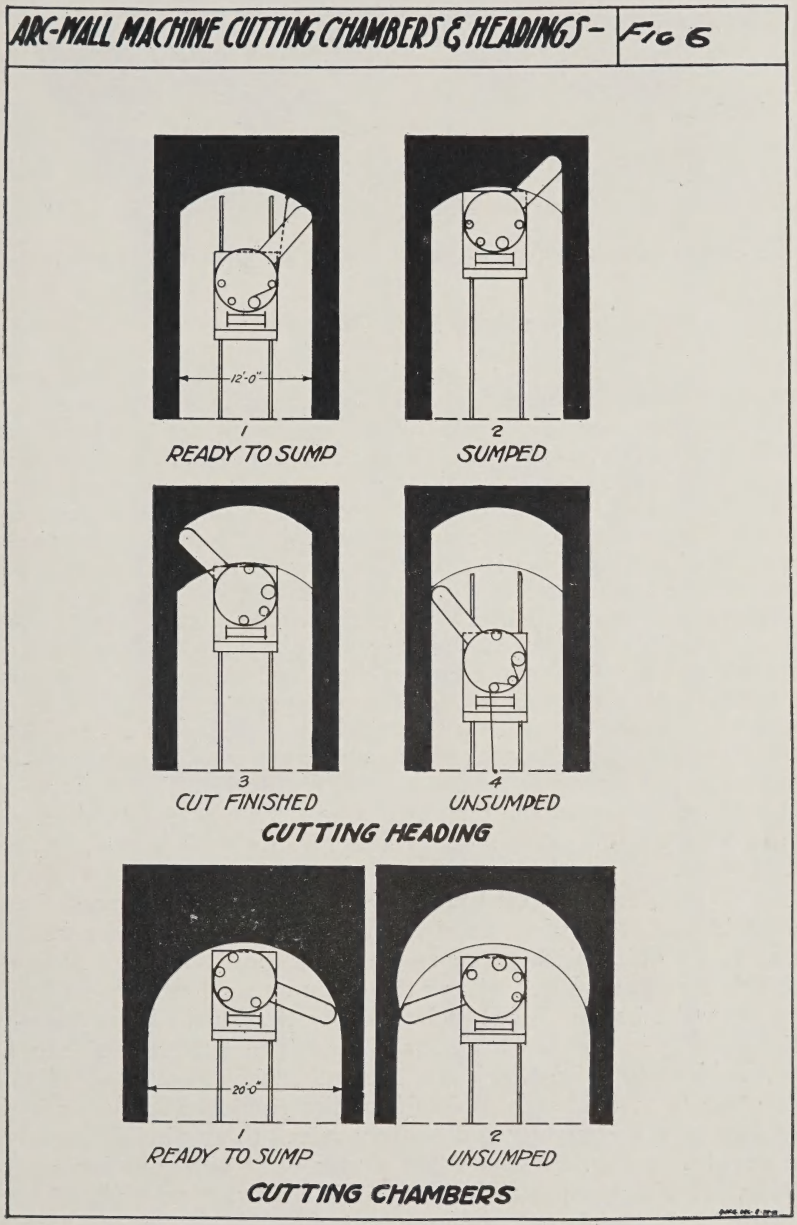


Figure 5—Arc Wall Machine Cutting 20-Foot Chamber.

Fig. 5 shows a perspective view of the machine in a position for cutting, Fig. 6 illustrates the methods used in cutting heading and in driving 20 foot chambers.



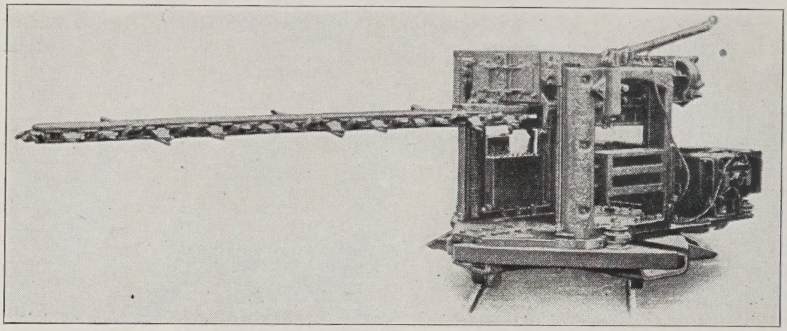
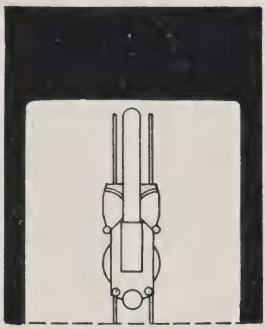


Figure 7—Straight Face Machine Arm in Position for Sumping.

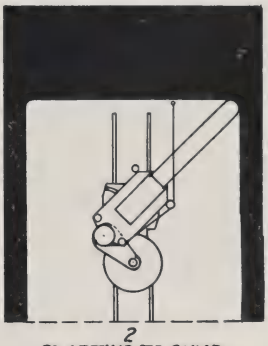
Straight Face Machine

The straight face machine, of which the Goodman is a good example, is, in a great many respects similar to the arc wall machine. Fig. 7 is a front view of the machine. The operation is wholly mechanical, the cutter is self-propelled, remaining on the track while it cuts, with one sweep, a straight face, cutting places from ten to twenty feet wide at any height. Automatic stops are provided for limiting the swing of cutter arm at any desired point at either side. The base of the machine is a steel casting mounted on four truck wheels. The top surface of the base on which the operating portion of the machine moves is machined. The cutter arm is adjusted by pinions working in racks at the four upright guides. Two motors are used, one for driving the cutter chain and raising and lowering the cutter arm, the other is used for feeding the machine, drilling for an anchor, and propelling the truck from place to place. The cutting element may be changed at any time from a center cutter to a top cutter or vice versa. A trolley pole is supplied for machines running on haulage headings, and a cable reel for chambers. Figure 8 shows the various operations in obtaining a straight face in a heading. When driving a 20-foot place the cutter arm makes a sweep of 180 degrees. Of much the same character is one of the latest Oldroyd types of which some illustrations are given herewith which show quite clearly the range of cutting positions possible with this machine. Fig. 9 shows the chain cutter head lowered to a level with the bottom, or 9 inches below the level of the bottom, if the cutting is not too hard for picks. The cutter head can be lowered so as to raise the front trucks 9 inches above top of rail. This permits machine to lift itself on the track. The cutter head may then be mechanically and quickly raised to any height or position required. Fig. 10 shows the cutter head adjusted for center cutting. If a higher position than this is required, cutter head may be turned over and raised to a maximum height of 6 feet 6½ inches, as shown in Fig. 11.

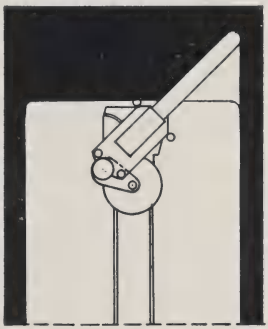
STRAIGHT FACE MACHINE CUTTING HEADING. FIG 8



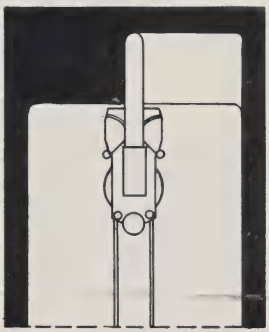
1
READY TO SUMP



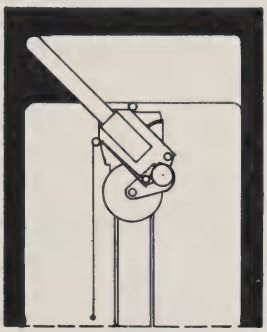
2
STARTING TO SUMP



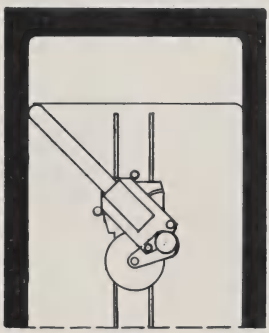
3
SUMPED



4
CUTTING



5
FINISHING CUT



6
UNSUMPED

Figure 9—Oldroyd Chain Cutter Head Lowered Down to the Bottom, Below the Rail.

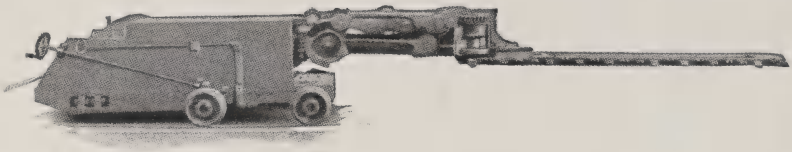


Figure 10—Oldroyd Cutter Head Adjusted for Center Cutting.

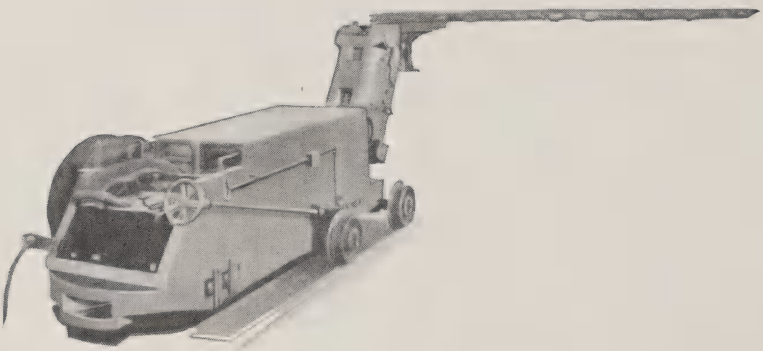


Figure 11—Oldroyd Cutter Head Raised Horizontally 6 Feet 6½ Inches from the Bottom.

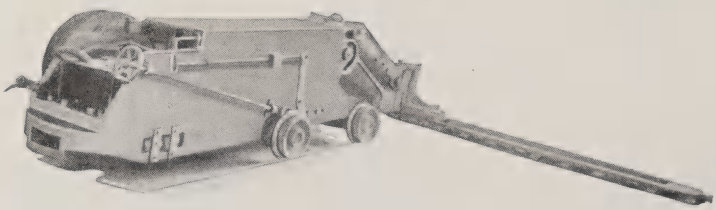


Figure 12—Oldroyd Cutter Head Adjusted About 18 Inches from the Bottom.

Fig. 12 shows cutter bar brought around to the right hand side of machine and adjusted about 18 inches from the bottom, ready to be brought around from right hand side across the face to undercut a room 20 feet wide. Fig. 40 also shows very clearly that the machine can be used for slabbing a rib where the track is laid within

two feet of the face of the coal. The same adjustment can be made in this position, that is from a level with the bottom to a height of 6 feet 6½ inches.

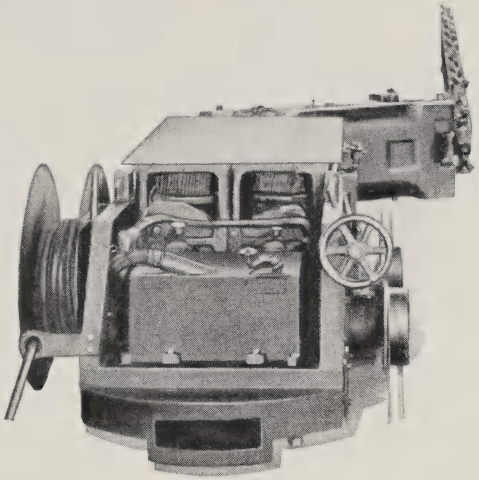


Figure 13—Oldroyd Cutter Arm Brought Over to the Right Side of the Machine Ready to Make a Shearing on the Right-hand Rib.

Fig. 13 shows cutter arm brought over to the right hand side of the machine, ready to make a shearing on the right hand rib. This shearing can be made by sumping in on a level with the top, or sumping in with the point of the bar on a level with the bottom, that is, the undercut can be made by bringing the bar up, or lowering the same down, after cutter bar is sumped under. The cutter bar can be adjusted horizontally across the face so as to make a shearing at any point required in an entry 8 feet wide. It will be noted in Fig. 13 that the machine is equipped with an automatic gathering reel to spool 350 or 600 feet of cable.

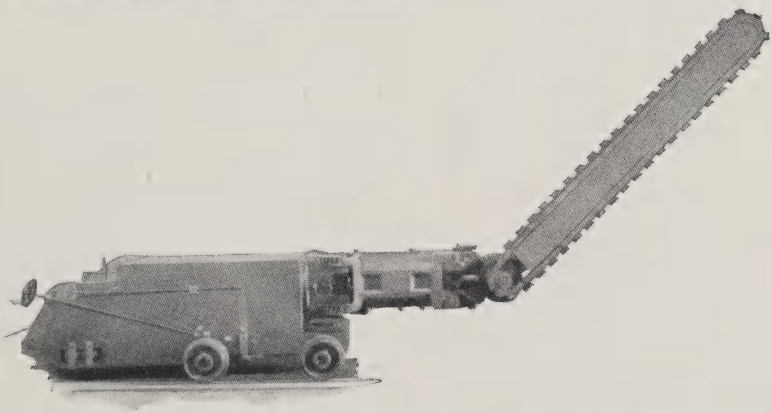


Figure 14—Cutter Head Adjusted to the Center of the Track, Ready to Make Center Shearing.

Fig. 14 shows Cutter Head adjusted to the center of the track, ready to make a center shearing with point of bar raised ready to sump under on a level with the roof.

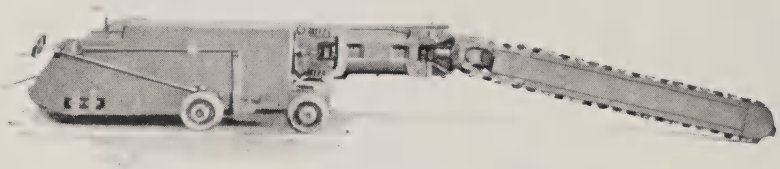


Figure 15—Shows Cutter Head Lowered to Floor Ready to Sump Under and Make Shearing Upward.

Fig. 15 shows cutter head lowered to the floor, ready to sump under and make a shearing upwardly. The point of bar can be brought up to a level with the roof, then the slow feed on the self-propelling track is reversed on a backmotion, drawing the cutter bar from under the coal, leaving a vertical shearing from the bottom to the top at any point required in an entry 8 feet wide.

Figure 16—Shows Cutter Bar Adjusted to a Level with the Top of Machine in position to Swing Across a Wide Room, or the Same Position Can Be Used for Slabbing.

Fig. 16 shows cutter bar adjusted to a level with the top of the machine in a position to swing across a wide room, or same position can be used for slabbing. By laying the track within two feet of a rib the bar can be brought around in the coal, or in a parting and machine arm be moved forward or backward along the face of coal. For cutting wide rooms at any width exceeding 20 feet, the track may be laid across the face and an undercut made at any point required from the bottom up to a height of 6 feet 6½ inches.

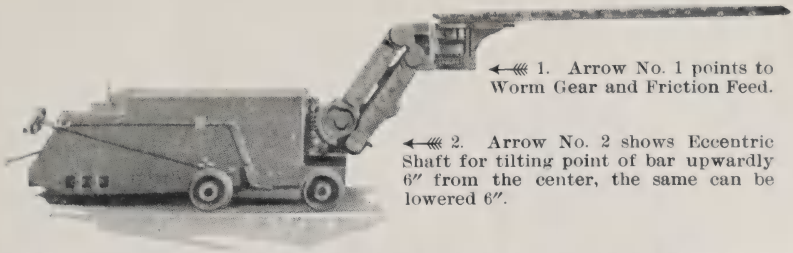

1. Arrow No. 1 points to Worm Gear and Friction Feed.
2. Arrow No. 2 shows Eccentric Shaft for tilting point of bar upwardly 6″ from the center, the same can be lowered 6″.

Figure 17—Shows Cutter Bar Adjusted as Top Cutter to a Height of 6 Feet 6½ Inches, ready to Sump Under in Center of the Track.

Fig. 17 shows cutter bar adjusted as Top Cutter to a height of 6 feet 6½ inches ready to sump in the center of the track, as Top-Cutter or Over-Cutter. When the bar is sumped under full depth it can be fed across the face from right to left, as may be to the best advantage. Arrow No. 1 on this view points to Friction Feed which can be regulated from 12 inches to 36 inches per minute. Arrow No. 2 points to eccentric shaft which is used for adjusting the cutter bar vertically, with the eccentric shaft the point of the cutter bar can be raised upwardly 6 inches, the same adjustment can be made downwardly, so as to take advantage of an entry or room that may be going to the dip or the rise, allowing you always to hold an even top or even bottom.

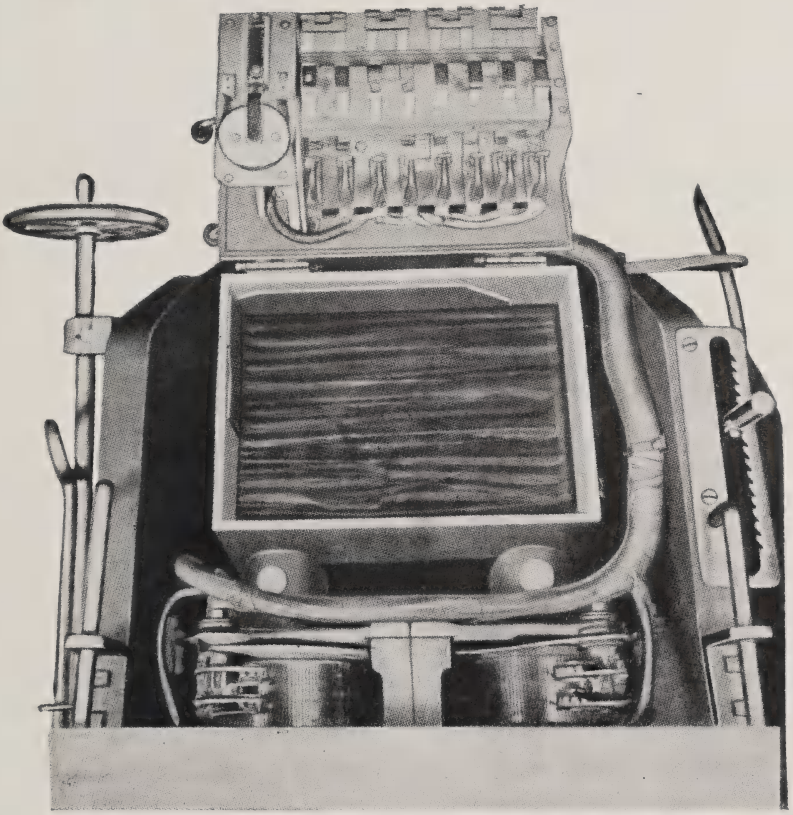


Figure 18—Oil Controllers for 250 or 500 Volts. Note the Accessibility in Getting to Contacts.

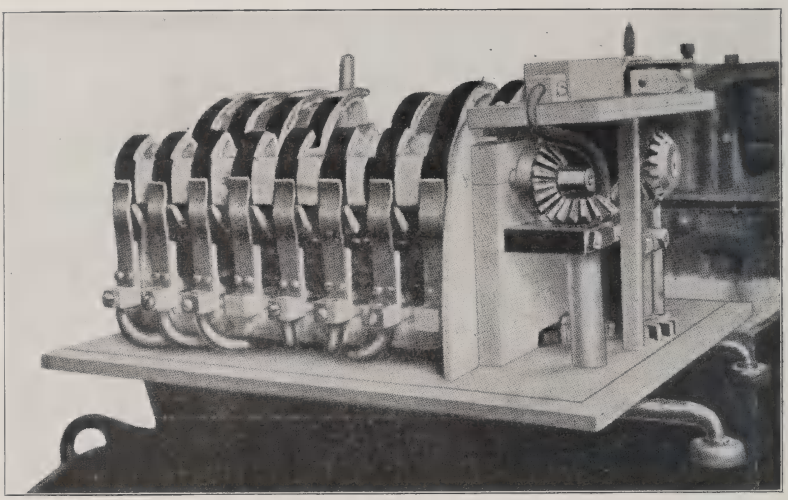


Figure 18½—Controller Cylinder and Contacts Raised from Oil Tank Ready to Make Any Repairs. It Will Be Noted When Cylinder Is Closed Down That All Contacts Are Submerged in Transformer Oil.

Fig. 18 shows Oil Controller for 250 or 500 volts. It will be noted that the cylinder of Controller and Contacts, Fingers, Fuse Wires and automatic Blow-Out Coil is mounted on cover of controller. When the cover is raised from oil tank, all the working parts of controller are brought out of the tank, allowing quick adjustment without disconnecting any of the cables or Leads from Armature or Fields.

These machines are equipped with one 50 H. P. motor for 30 minutes rating, or 65 H. P. for 15 minutes rating. Motors are wound for 250 or 500 volts Direct current. A. C. Motors can be used if desired. The cutter bars are made any length from 5 to 10 feet, and the machine is equipped with a powerful handbrake which is used in holding it to the face on heavy grades, and also when propelling on entries.

Short Wall or Continuous Coal Cutters

The short-wall mining machine has come nearer solving the problem of mining anthracite by machines than any other device so far invented. It occupies small space thus allowing props to be set close to the face; it accommodates itself to an uneven bottom and an irregular coal face; it unloads and loads itself by its chain or rope feed; it has a rapid cutting capacity and requires no laborious work on the part of the operatives.

To the Sullivan Machinery Company is due the credit of developing this type of mining machine. After a number of years of

experimenting, the first machine was brought out in 1902. At the present time there are four companies manufacturing continuous cutters. In design, and principle, these machines are similar, but differ from each other in detail.

The motors have been designed to meet the mining laws, especially where they operate in a gaseous mine, and either direct current or alternating current motors are furnished. The direct current motors are compound wound. In some machines the armature stands in a vertical position, thus doing away with bevel gearing. Fig. 19 shows the base and gearing of a machine with vertical armature shaft.

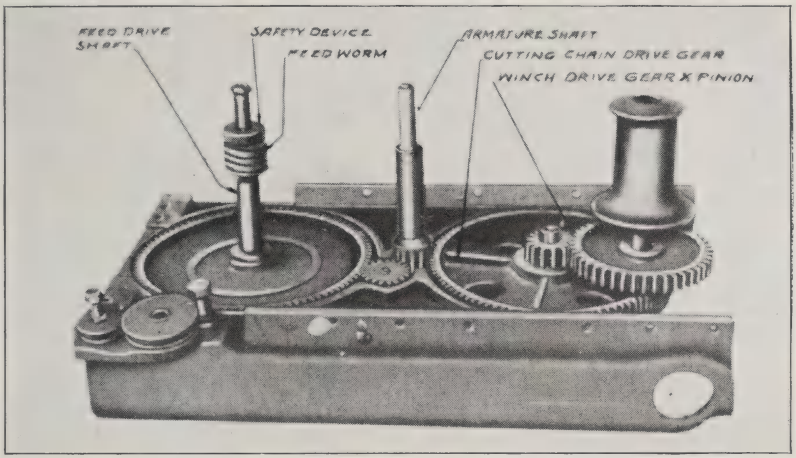


Figure 19—Base and Gearing for Vertical Armature.

The motors are rated from 30 to 50 H. P. for one hour continuously. For gaseous mines, the motor and all other electrical parts are enclosed in an "explosion-proof" casing, and no machine should be allowed to work in a gaseous mine unless it bears the approval stamp of the Bureau of Mines. With some mining machines the motors may be changed from the open type to the "permissible explosion proof" type, by alterations that may be made in the field.

In order to more clearly understand the difference in operation between the continuous cutter and the chain breast machines, Fig. 20 is shown and should be compared with Fig. 21, which shows the operation of the chain breast machines. It will be noted that this machine makes the cuts in a series of runs or boards, each about the width of the cutter head. It will also be noted that the props are set from 12 to 14 feet from the face. Now by referring to Fig. 20, it will be seen that the continuous cutter makes one clean cut across the face without withdrawing the jib, or cutter bar, and that the props may be set within five to six feet of the face.

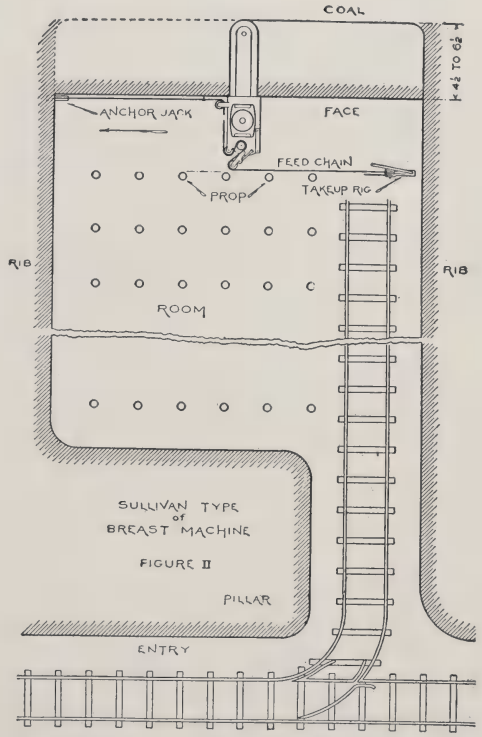


Figure 20—Plan of Chamber With Short-Wall Machine Cutting Across Face.

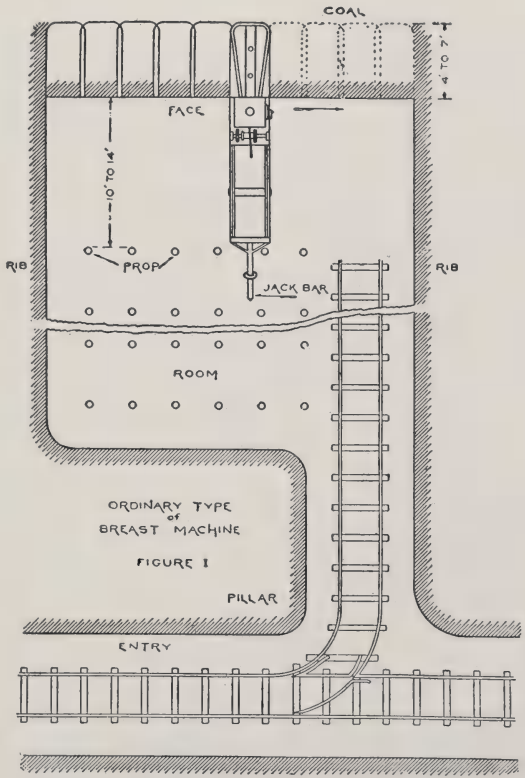


Figure 21—Plan of Chamber Mining With Chain Breast Machine.

In the following description of the continuous cutter, the four different makes of machines and a few details are illustrated.

Fig. 22 shows the Goodman Short-Wall machine in cutting position.

Fig. 23 shows the Jeffrey Short-Wall machine.

Fig. 24 shows the Morgan Gardner Short-Wall machine with sheaves and guides for carrying the steel feed rope or drag line.

Fig. 25 shows the Sullivan Short-Wall machine, the upper view of which shows the machine sumping with pan and sumping bar. The bottom view shows the position for making a continuous cut across the face with pan removed. The machine is set to cut from left to right.

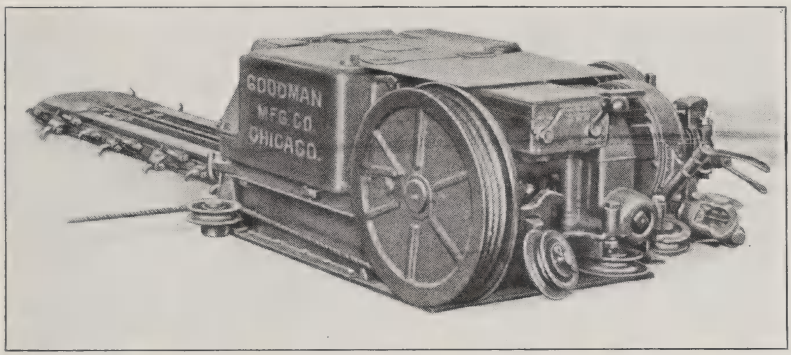


Figure 22—Goodman DA Short-Wall Machine.

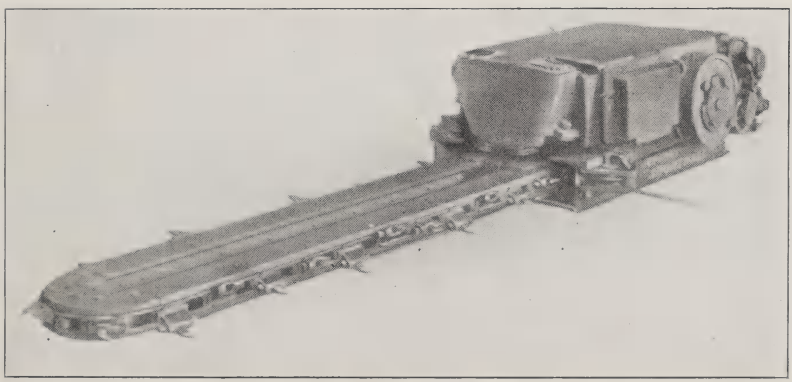


Figure 23—Jeffrey 35-A Short-Wall Machine.

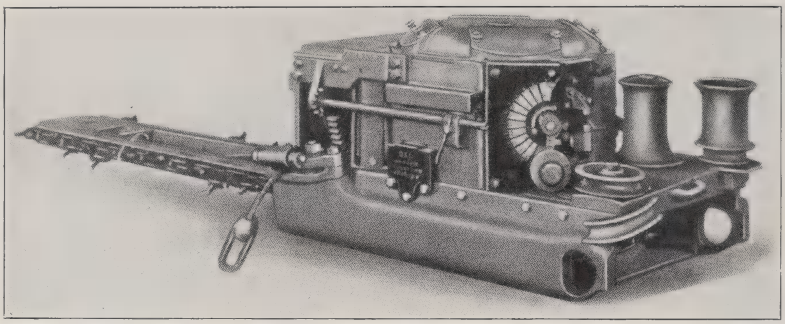


Figure 24—Morgan-Gardner SA Short-Wall Machine.

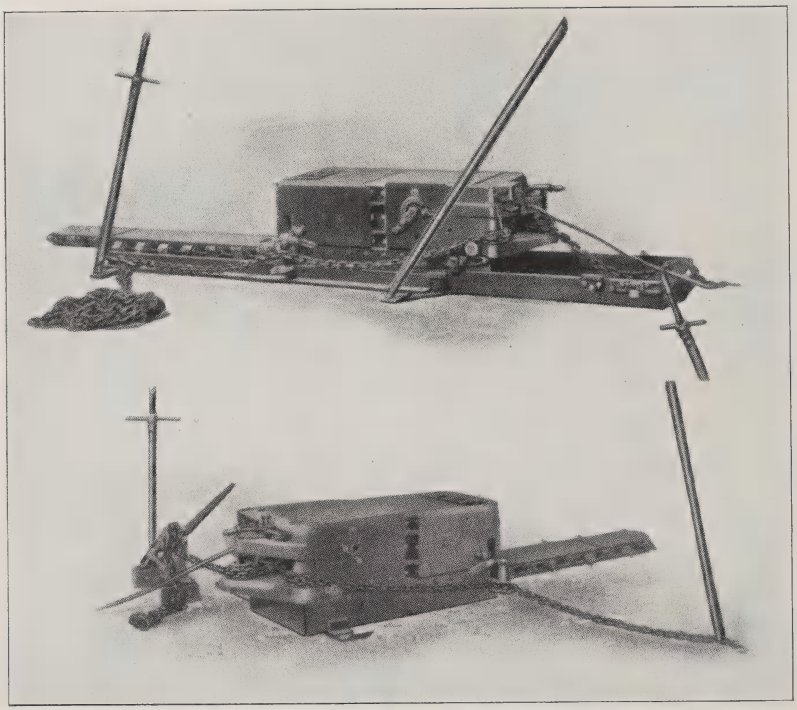


Figure 25—Sullivan Iron Clad Short-Wall Machine.
Top View Shows Machine Sumping With Pan and Sumping Bar. Lower View Shows Machine in Position to Cut from Left to Right.

Sketches of the Goodman machine are shown in Figs. 26, 27, 28 and 29 which give a picture of its construction. On one machine the cutter arm is of solid, built up construction, with top and bottom smooth. This construction has a tendency to prevent the arm from being jammed by the coal or caught by rough bottom. Fig. 30 shows cutter arm and chain described above. The other cutter arms are open in the center and are either built up or solid, one piece, castings. Fig. 31 illustrates this type of cutter arm.

Goodman Type 12-DA Short-Wall Machine.
(Reversible)

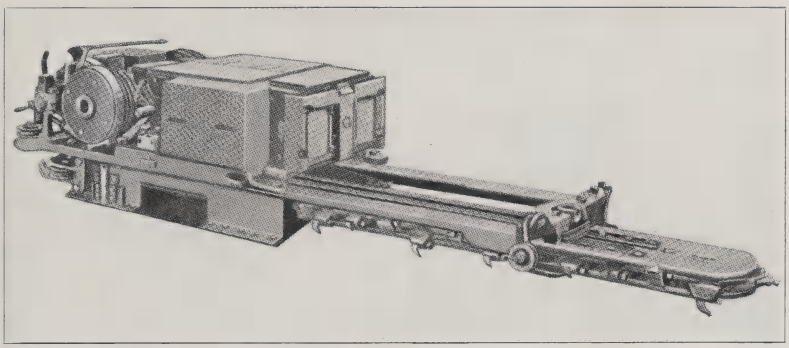


Figure 26—Goodman Type 12-DA Short-Wall Machine.

Goodman Type 12-DA Short-Wall Machine.
(Reversible)

Back View.

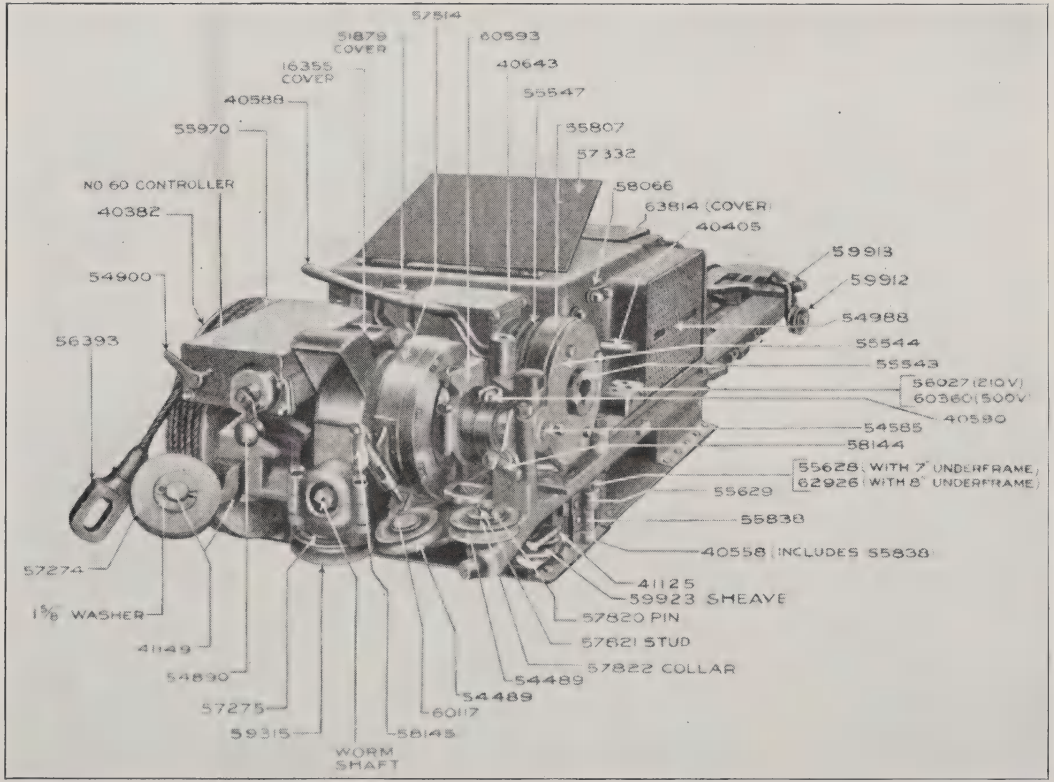


Figure 27—Goodman Type 12-DA Short-Wall Machine—Back View.

Goodman Type 12-DA Short-Wall Machine.

(Reversible)

Showing Operating Levers and Places for Oiling Bearings, Gears, Chain, etc.

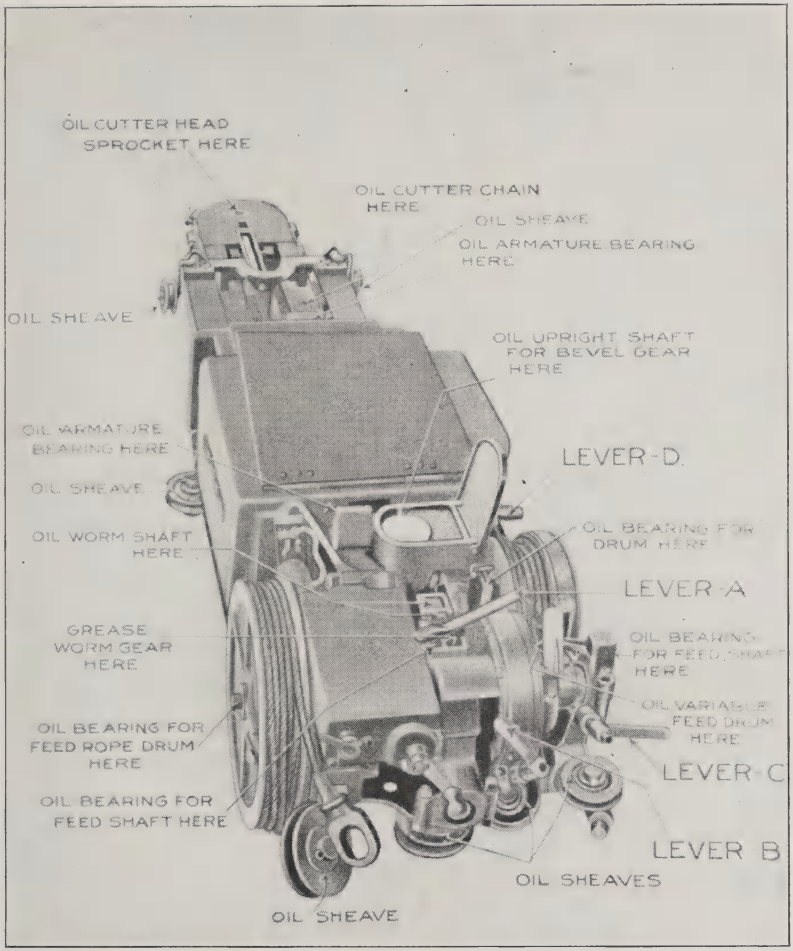


Figure 28—Goodman Type 12DA Short-Wall Machine Showing Mechanism.

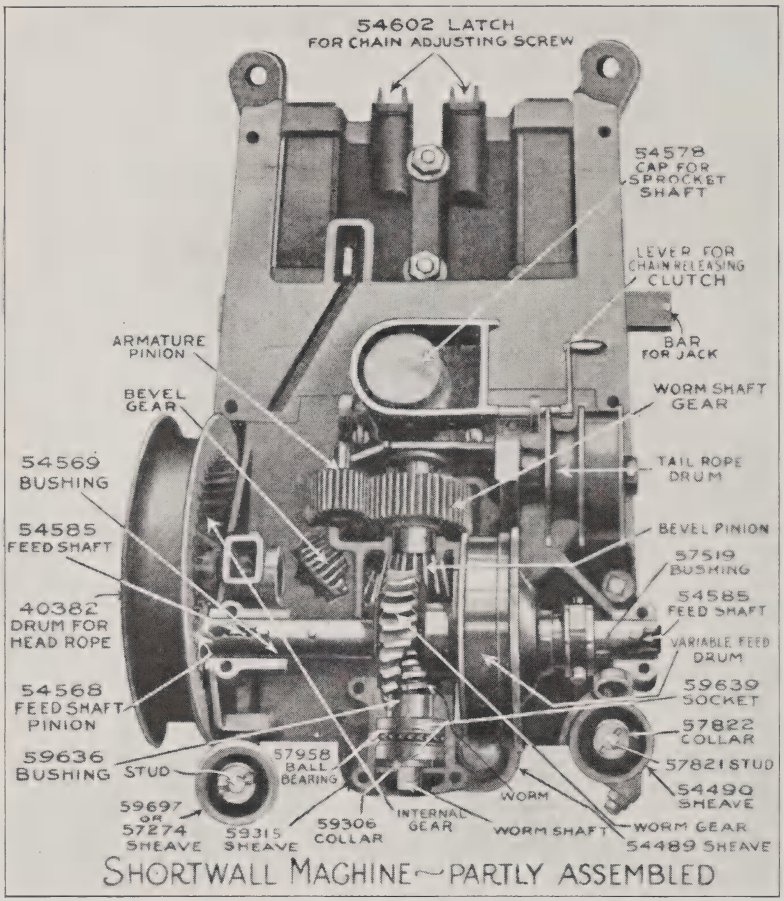


Figure 29—Goodman Type 12-DA Machine Partly Assembled.

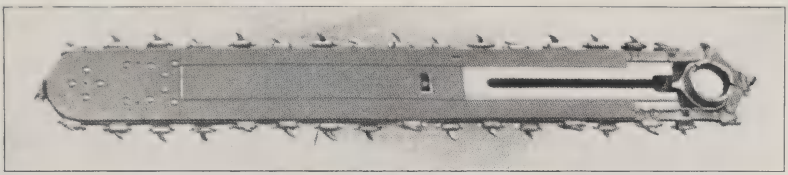


Figure 30—Solid Cast Steel Cutter Arm.

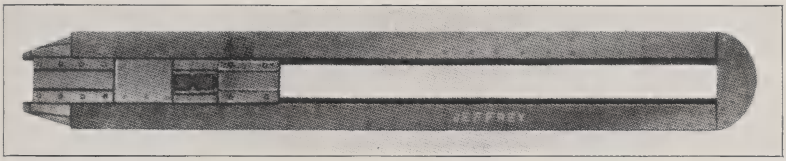


Figure 31—Solid Built-up Cutter Arm.

Arms are furnished in lengths from 3½ to about 10½ feet to suit conditions. These arms are narrow, thus reducing the possibility of cramping or being caught under the coal, and allowing more freedom for guiding the arm upward or downward when cutting.

On one make of machine there is a chain guard which covers the cutter arm and chain when being moved from place to place. The guard slides under the machine when the sumping cut is being made. The chain and bits travel around the cutter arm, being driven by a sprocket wheel on the machine end of the arm. The chain is kept in proper tension by an adjusting screw on the arm. In some of the machines the chain is made reversible, that is, the cutter arm will work from right to left or from left to right across the face. Fig. 32 shows a cutter chain.

The details of design of chains differ somewhat in the various makes of machines. The chain consists of blocks and straps so pitched that they engage with the sprocket wheel on the arm. In the blocks, the bits are held by means of set screws. The blocks are made for single or double bits or a combination of the two. The bits of either pick pointed or chisel pointed or a combination of the two arranged in three to nine positions to suit the cutting conditions.

In feeding the cutter arm into the coal, a chain or rope is used, running through friction clutches or wound around a drum or

Goodman Type 12-DA Short-Wall Machine.
(Reversible)
Parts for No. 35 Reversible Bushed Cutter Chains.
(Seven Positions for Blocks)

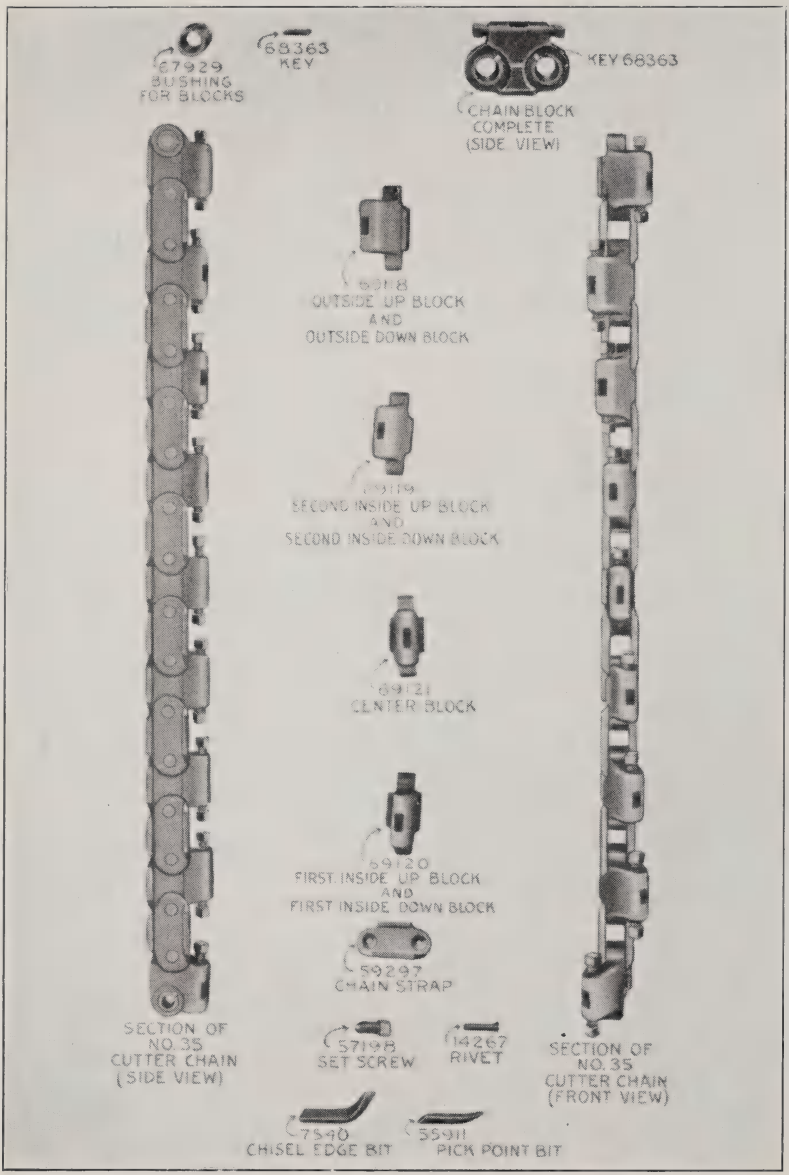


Figure 32—Goodman Type 12-DA Short-Wall Machine Reversible Bushed Cutter Chains.

sheave with either a positive feed clutch or a hand controlled friction. The drag line or tail rope is automatically or hand controlled, and governs the angle at which the cutter arm works, thus keeping the machine in proper position for cutting.

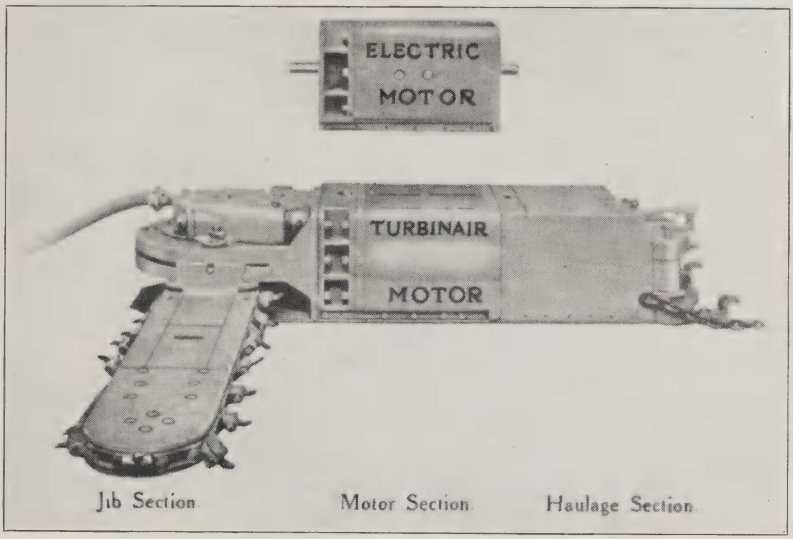
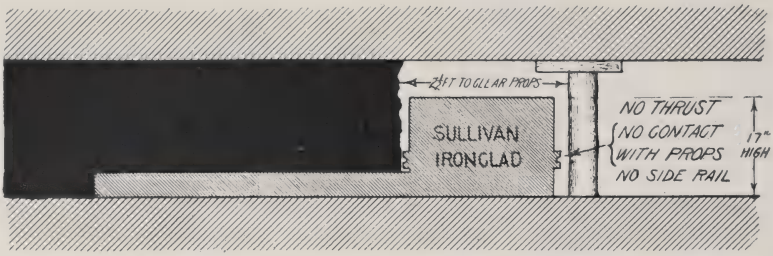


Figure 33—One of the Latest Types of Long-Wall Machines.

Long-Wall Mining Machines

Fig. 33 shows one of the latest machines of this type. This machine consists of three sections as shown. The first section is the jib and cutter chain mechanism; the second section or central section comprises the motor, which may be either electricity or air. In the figure the air motor is shown in place, with the electric motor shown above. With a few alterations these motors are interchangeable. The third or front section contains the hauling mechanism. All of these sections are rigidly held in place on one base plate. This machine is 29 inches wide, about 8 feet long and 18 inches high, and the motors are of 30 to 50 H. P.

The jib is held in position at right angles to the body of the machine by a locking pin. It is reversible, that is to say, it may be turned about 210 degrees so as to cut right or left handed. The jib may also be locked in a central position for transportation from place to place. When sumping, the haulage chain is attached to the jib and slewed under the coal until the locking pin drops in place.



Cross Section through coal seam with Ironclad at face.

Figure 34—Cross Section of Machine Cutter Arm Under the Coal.

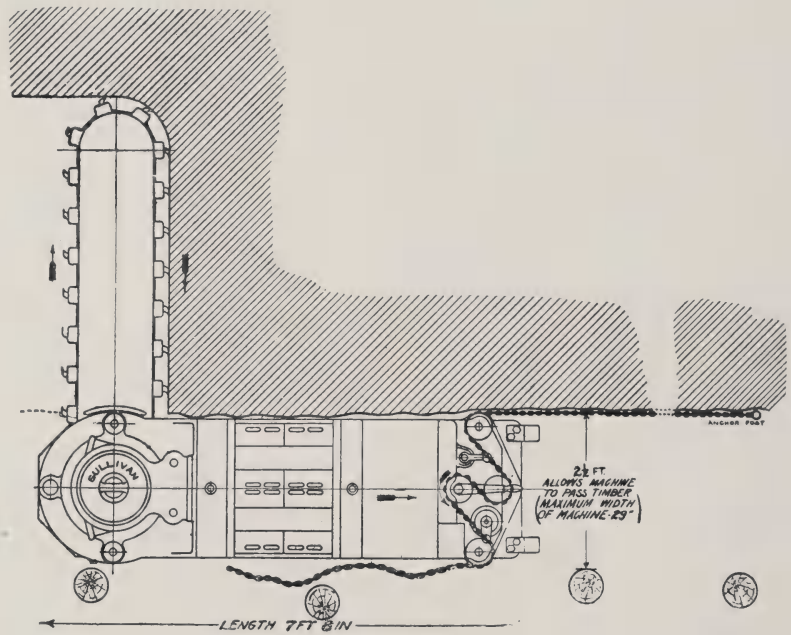


Figure 35—Plan of Long-Wall Machine Cutting from Left to Right.

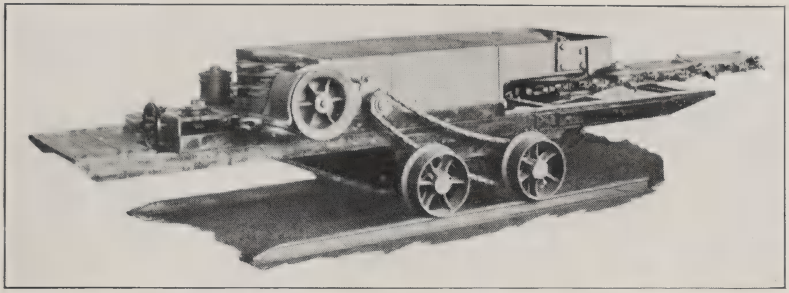


Figure 36—Jeffrey Long-Wall Machine—Mounted on Truck.

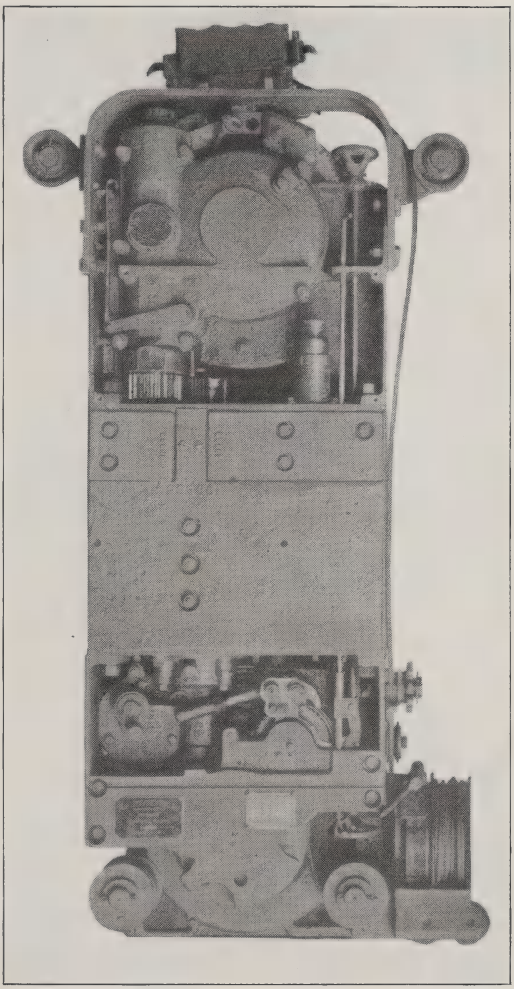


Figure 37—Jeffrey Long-Wall Machine—Top View With Cover Removed.

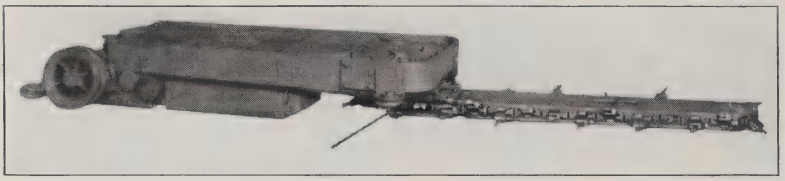


Figure 38—Jeffrey Long-Wall Machine.

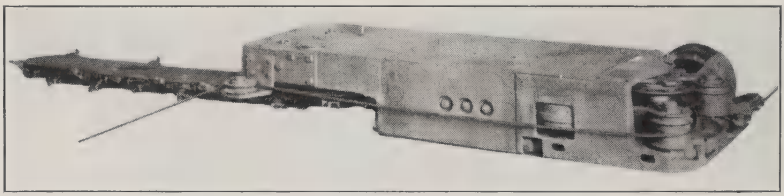


Figure 39—Jeffrey Long-Wall Machine.

Fig. 34 shows cross-section of a coal bed with the jib undercut below the coal, and the body of the machine close to the face. It will be noted how close the props may be set to the face when necessary.

Fig. 35 shows a plan view of the machine in operation.

Figs. 36, 37, 38 and 39 illustrate the modern Jeffrey Long-Wall Cutter with swinging cutter arm.

CHAPTER 2

AUXILIARY APPLIANCES

Trucks

In order to keep up with the speed of the mining machine, it is necessary to follow its work with other labor-saving machines or devices. This is especially so at the present time on account of the scarcity of mine workers, and the thinness of the beds being worked.

For moving the machine from place to place the self-propelled truck is almost indispensable. All of the companies manufacturing continuous cutters furnish self-propelled trucks with their machines. Trucks may be equipped with trolley poles, which is an advantage when the truck is moved long distances over main haulage roads. Usually they are geared to travel about three and one-half miles per hour. The platforms on which the machine rests had originally, one section, so that under some conditions the rear wheels would be raised off the rails, when the machine was being unloaded. Later the platform was built in two sections, the front section hinged over the front wheels as shown in Fig. 40. This truck is known as the "drop front truck."

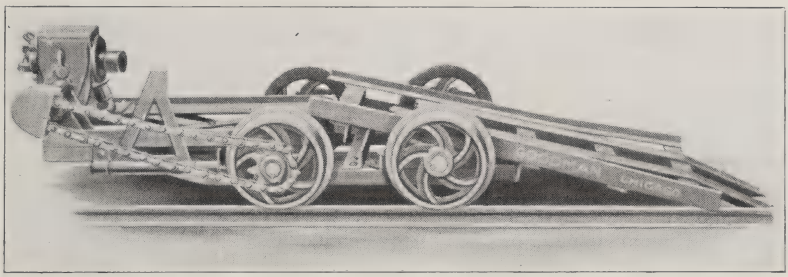


Figure 40—Goodman Drop Front Truck.

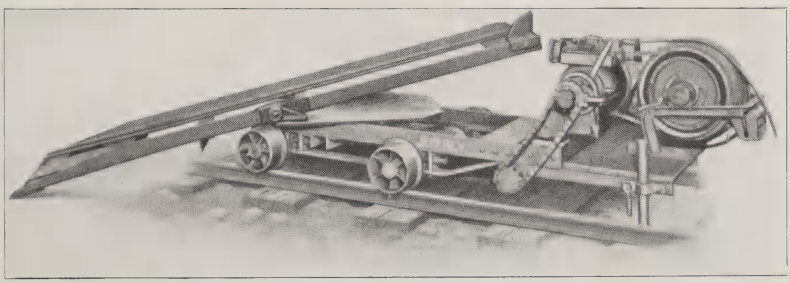


Figure 41—Jeffrey Turntable or Swivelled Drop Front Truck.

Another form of truck is known as the "Turntable truck." The platform turns to any angle in a horizontal plane but does not tilt or drop, while a second type combines the "drop front" and "turntable" feature which allows the machine to be unloaded or loaded directly from each corner of the chamber, or the platform may be turned at right angles to the road for the purpose of unloading the machine to cut cross-cuts or open chambers. This form of truck is shown in Fig. 41. In still another type of truck the front wheels of the truck are made smaller in diameter than the rear wheels, thus giving the platform a slight pitch forward.

Figure 42—Goodman Machine on Truck With Reel Trailer Attached.

Cable Reel

This device is used to automatically pay out or take up the electric cable, thus prolonging the life of the cable. The reel is either attached to the truck as shown in Fig. 41, or carried on a separate truck coupled to the machine. In such a case, the device is called a "reel trailer," and is shown in Fig. 42.

Electric Drills

The use of electric drills in the Anthracite Region is not very general on account of these drills not being adapted to all conditions as air drills are.

There are two types of electrical drills; Figs. 43 and 44, namely, a directly driven electrical drill of the auger type, and the other an electrical drill where the electrical part drives a small air compressor which in turn runs the drill as a percussion drill.

Of the first type drill, there are several different makes and sizes. The Fort Wayne drill is a heavy type auger drill mounted either on a tripod or column, and weighs 575 lbs. This drill has given good results in drilling coal, and the average rock in the Northern Anthracite fields. The great disadvantage of this drill is its weight and size, thus limiting its usefulness to operations where four or five men are employed to handle it and space enough to put it in.

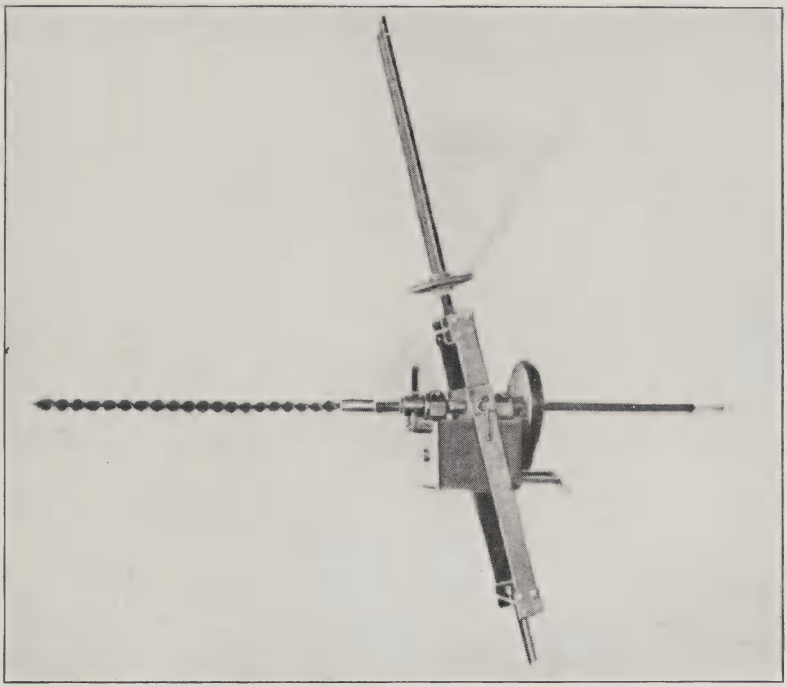


Figure 43—Electric Drill.

Also, there is a drill made by the Howell Drill Mfg. Company. This is an auger type drill weighing about 200 pounds, and is more easily handled than the Fort Wayne drill. This drill seems to give good results in coal, and can drill the softer stratas of rock. This drill is also a heavy drill for general mining purposes, as it takes two or three men to handle it and requires room to work it in.

There is an auger type drill made by the Chicago Pneumatic Company, and also by the Pneumelectric Company of Syracuse, N. Y. These drills weigh about 50 pounds, and from experiments we are making with these drills, they seem to drill the coal satisfactorily. We are making tests on drilling rock which are not complete enough to arrive at a conclusion. If these drills will stand up on both coal and rock, they should be a very good drill for all mine purposes.

Of the second type or percussion drill, the amount of machinery makes these drills very heavy and cumbersome and restrict their use, and unless considerable improvement is made on them, they are not a practical all around mine drill.

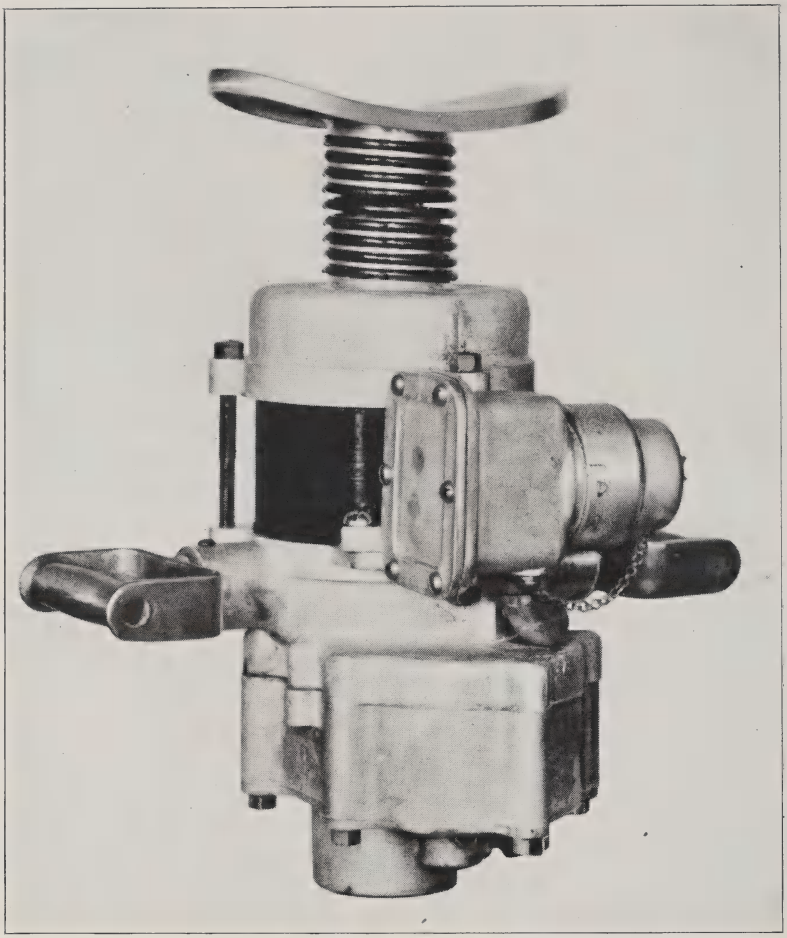


Figure 44—Electric Coal Drill.

An electrical drill to be a success in the coal regions must be able to compete with a jackhammer air drill which is in general use; that is, a drill not exceeding 55 pounds in weight, to be able to drill either coal or rock at a good speed, to be able to stand the work with a low maintenance cost not to exceed that of the jackhammer, also to be so constructed as to eliminate any possibility of short circuiting and shocking the miner, as one shock from a drill will finish any further use of it by that man, and it must be adapted for work under both dry and wet conditions.

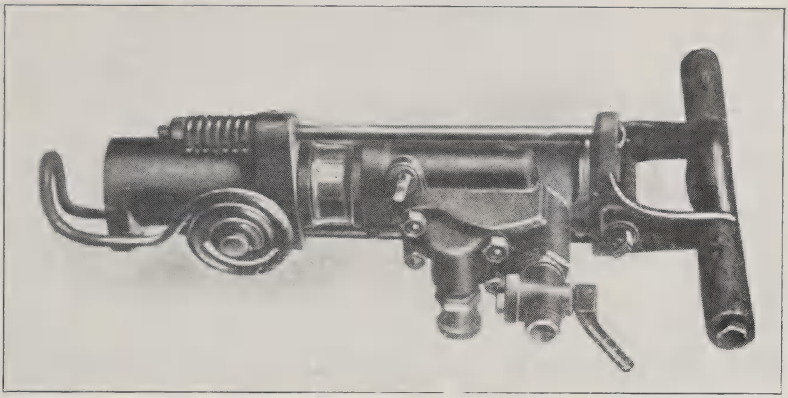


Figure 45—The Jackhammer.

Jackhammer Drill

The jackhammer is an air driven machine capable of being carried by the miner from place to place. It is 18 inches long with a cylinder diameter of 2½ inches by a stroke of 2 inches with an air connection for ¾ inch hose, and weighs 40 pounds. Fig. 45 shows the jackhammer drill with its hose connection to air valve. In construction the machine is very simple. A rifled bar and ratchet are located in the back of the cylinder, and impart rotation to the piston, which in turn imparts rotation to the drill. The spring device on the lower end is used to hold the drill in the machine. The handles on the other end are sometimes rubber covered, making it easier for the operator to hold the machine to its work. These details are shown in Fig. 46, which is a skeleton view of the jackhammer. Drills may be used in this machine up to 12 feet in length. Twisted drills are being employed generally for drilling coal, and solid hexagonal chisel pointed bits are used in the rock.

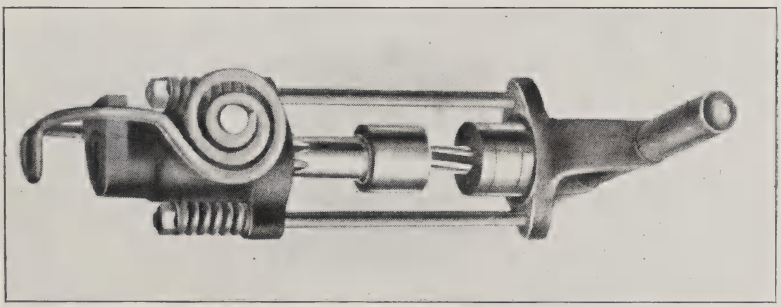


Figure 46—Jackhammer in Skeleton.

The jackhammer will drill in the coal from 1½ to 2 feet per minute actual drilling time. Taking into consideration the time of rigging machine and getting ready to drill, from 9 to 12 inches can be drilled in the coal per minute. The actual drilling time in rock is from 1 minute to 1½ minutes per foot, depending, of course, upon the hardness of the rock.

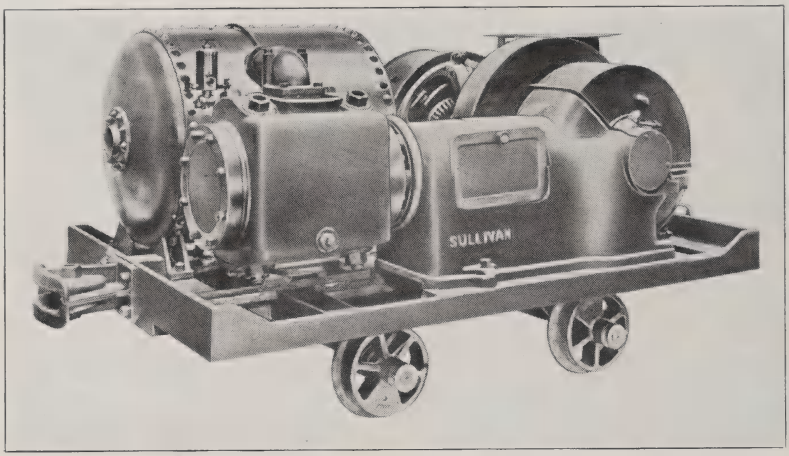


Figure 47—Sullivan Electrically Driven Portable Air Compressor.

Compressors

While the portable air compressor can hardly be considered an auxiliary mining machine, nevertheless, it plays an important part in driving jackhammers in mines not equipped with a central air compressor plant. Even where there is a central plant, it is sometimes economical in remote sections of the mine to install a portable air compressor. The compressor is driven by an electric motor, and is suitable for pressure of from 50 to 100 pounds. The machine is self-contained and mounted on a truck of any gauge to suit conditions. An illustration of a portable air compressor is shown in Fig. 47.

CHAPTER 3

LOADING APPLIANCES

This class of machinery came into mining partly as a natural sequence to coal cutting and partly to fulfill a field of its own. These appliances in use can be divided as follows:

(a) Shovels and loading machines.
(b) Conveyors.
(c) Scrapers.

Figure 48—Thew Electric Shovel Built for Underground Use.

(a) Mechanical Shoveling

Mechanical shoveling is largely the outcome of attempts to apply steam shovel methods to underground work. It is only a recent development and has resulted in the design of two distinct types of machines. The first of these types is shown in Fig. 48, and is a steam shovel only slightly altered in its general arrangement, so as to be capable of operation in underground chambers, where limitations of space, both horizontally and vertically, have to be overcome. The shovel illustrated is electrically driven, provided with boom and bucket, and moves on a caterpillar track. It is

Figure 49—Recent Photograph of No. 2 Type Myers-Whaley Company Shoveling Machine in a 4½ Seam of Coal.

capable of handling 400 tons per day under favorable conditions. The sketch readily illustrates the fact that these machines can only be utilized in very thick beds, their design precluding performance in beds less than 9 feet thick, and for this reason their sphere of usefulness is limited.

A type of loading machine is the Myers-Whaley Loader. This machine is a relatively low and long machine, self-propelled on the mine tracks, with a special shovel in front and a conveyor at the back. Fig. 49 shows the operation of this machine in a chamber where the vein is only 4½ feet in height. The shovel is the most peculiar part of this machine. It is a double revolving scoop, one within and discharging to the other. The first scoop has the thrust motion, picks up its load, turns backward and unloads to the second scoop, which repeating the revolution in time to return below the first scoop, loads on to the conveyor and hence to the car. The machine swings radially two ways, the front end so that it can operate over the width of the room, and the back end with the conveyor so that loading can be done into the car in practically any position. Where there is a large tonnage to load, this machine can do considerable work, and has been known to load at the rate of 20 to 40 tons per hour. In Virginia, this machine was used in a long-wall face, with the cars following, and loaded 250 tons in 8 hours, an average of 30 tons per man employed. The coal was 4 to 5 feet thick. A photograph of this type of machine loading culm is shown in Fig. 50. The success of any mechanical loading machine depends on continuity of operation, and when there are only a few tons per place and much loss of time traveling from room to room, their efficiency is low. Further, they are bulky, and awkward to handle in any but the highest and best of mine roads.

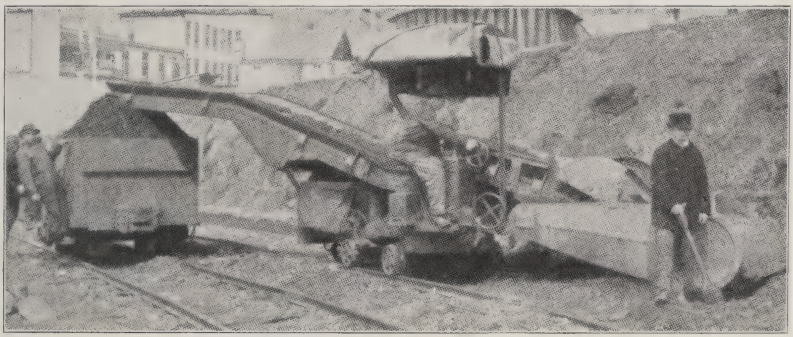


Figure 50—No. 4 Size Machine Loading Anthracite Waste Dump. Myers-Whaley Loading Machine Loading Culm.

(b) Conveyors

In very thin beds, or where the cost of moving bottom or top rock to obtain height sufficient for the mine car to follow to the face, is prohibitive, the coal is sometimes loaded into the mine cars by

means of a conveyor line, traveling along the long-wall face to the mine car on the gangway.

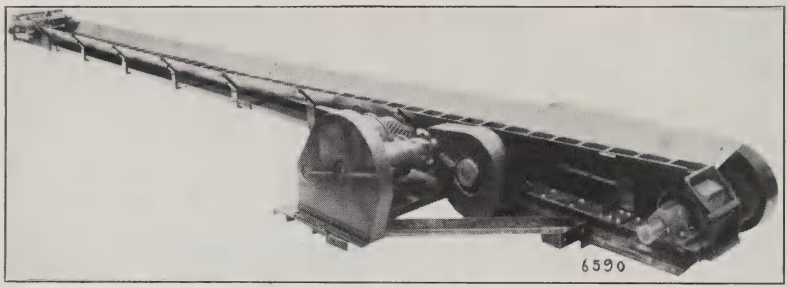
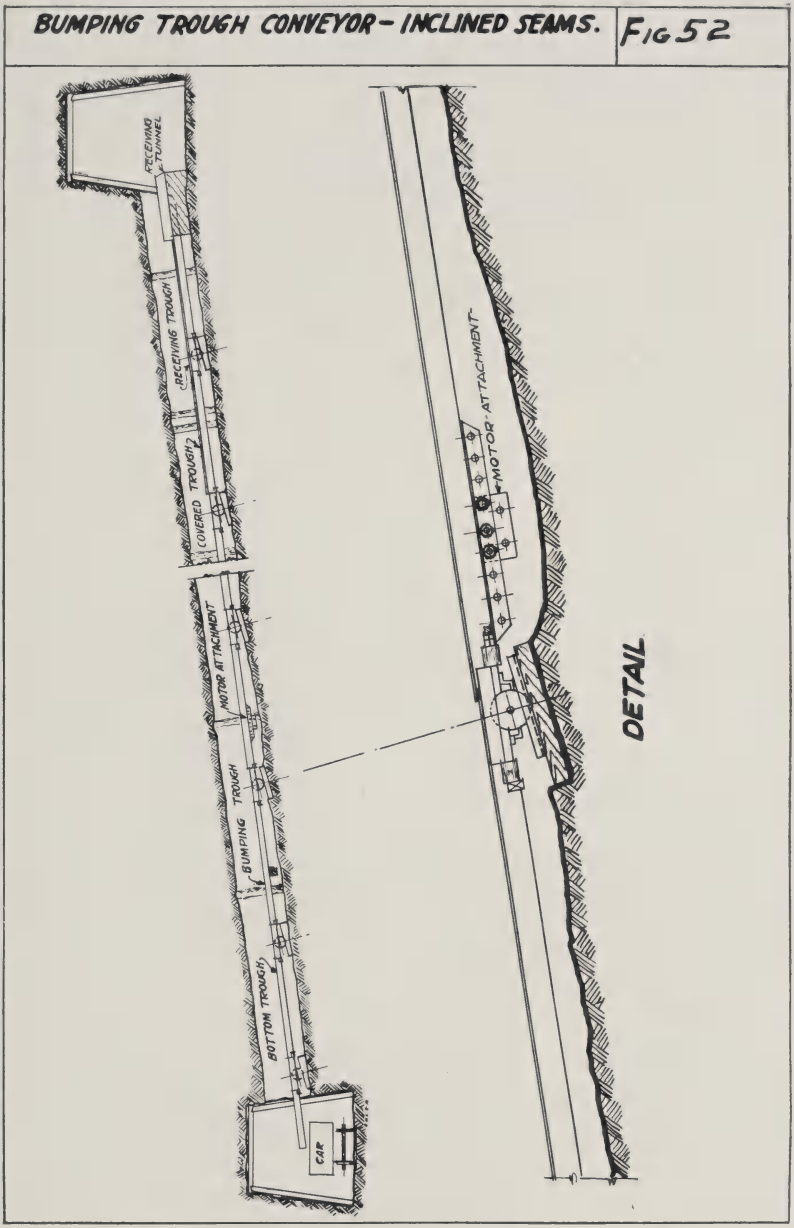


Figure 51—Perspective View of Complete Jeffrey Chain Conveyor Outfit.

When mining machines are used in very thin beds, the problem of moving the coal is a serious one. The cost of taking up bottom rock in headings is an enormous item of expense. With main conveyors in lateral headings and scrapers and conveyors feeding the main conveyors, the coal could be delivered to the main headings and loaded on cars, thus doing away with a great deal of rock work. Next to the mining machine, no improvements in mining thin beds have been more valuable for handling and loading coal than the conveyor and its later developments. Notwithstanding that the conveyor is better adapted for long-wall work, and that this method of mining is very much more practiced in European countries than in the United States, the conveyor is the invention of an American. There are a number of forms of conveyors used for handling coal in the mines, the chain and trough conveyor, the belt conveyor, consisting of an endless belt of canvas or rubber, and the moving trough conveyor. The first mentioned, or the chain and trough conveyor, is the form mostly used for handling anthracite. The links are from 9 inches to 12 inches wide moving in a steel plate trough with flaring sides, the return run of the chain being made over an angle steel track located under the trough. The trough is made in sections from 12 to 16 feet long, supported on steel legs or stands, and the conveyor is operated by an electric motor placed near the discharge and speed of travel is from 90 to 125 feet per minute. Fig. 51 shows a perspective view of the conveyor. The chain on this conveyor is 9 inches wide, travels 90 feet per minute with a capacity of ten tons per hour. The full length of the conveyor may be shifted with bars so that it is kept close to the working face at all times. Fig. 96 shows the chain that drives the sprocket wheel, which in turn moves the conveyor line.

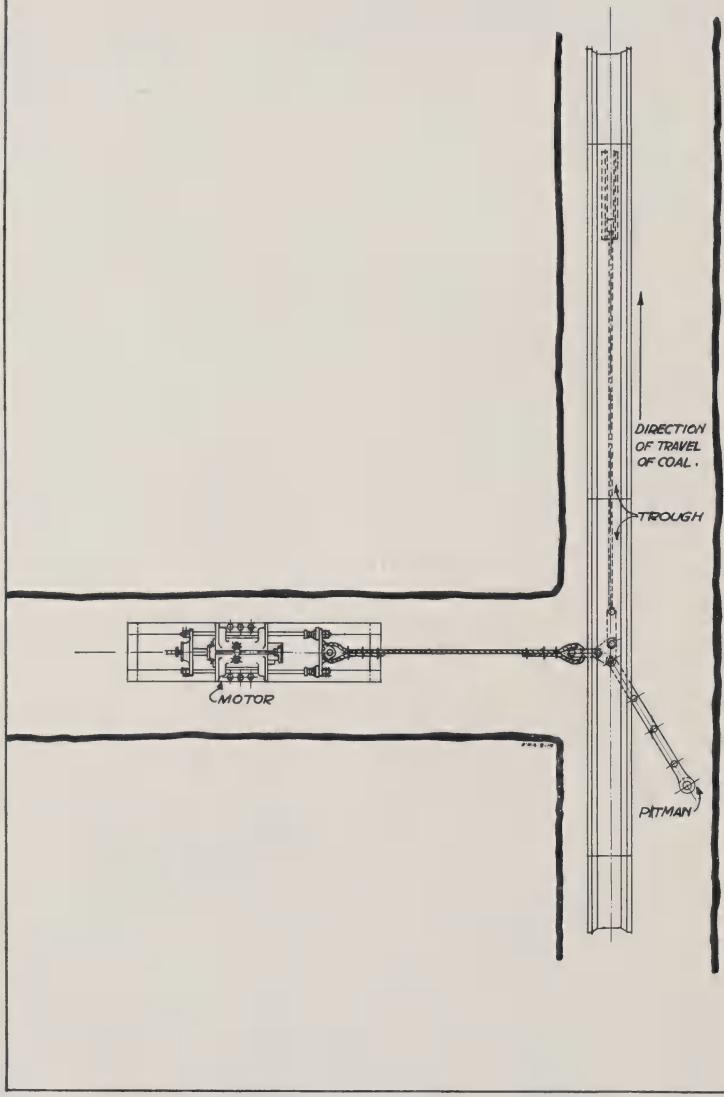
The belt conveyor is similar in action to the trough conveyor. Instead of a chain, however, there is a moving belt running on rollers which carries the material from face to car.



A form of conveyor much used in European countries is the moving trough conveyor shown in Fig. 52. The actuating mechanism is shown in Fig. 53. The essential details of operation are that one motion of the motor pulls the trough up the pitch for a

few inches (and artificially created by the use of wheels in an inclined trough) the reciprocating motion releases it. This conveyor thus abruptly falls away after the material has been carried forward, and so in this manner shifts its contents along the trough. This repeats on the next cycle of the motor.

ACTUATING MECHANISM OF TROUGH CONVEYOR SYSTEM FIG 53



These appliances have been placed under the head of conveyors and as such they are not loaders in the strict sense of the term. The loader is a machine which mechanically loads the cars, while these appliances do not, as they have to be themselves loaded by the miner or his laborer.

(c) Scrapers

In the development of thin coal mining, the application of the scraper has played an important part. This device is more flexible than a conveyor and has the advantage over the conveyor in that it loads itself and is better adapted to chamber mining than the conveyor where the pavement is hard. At the same time, the scraper may be used advantageously for long-wall mining.

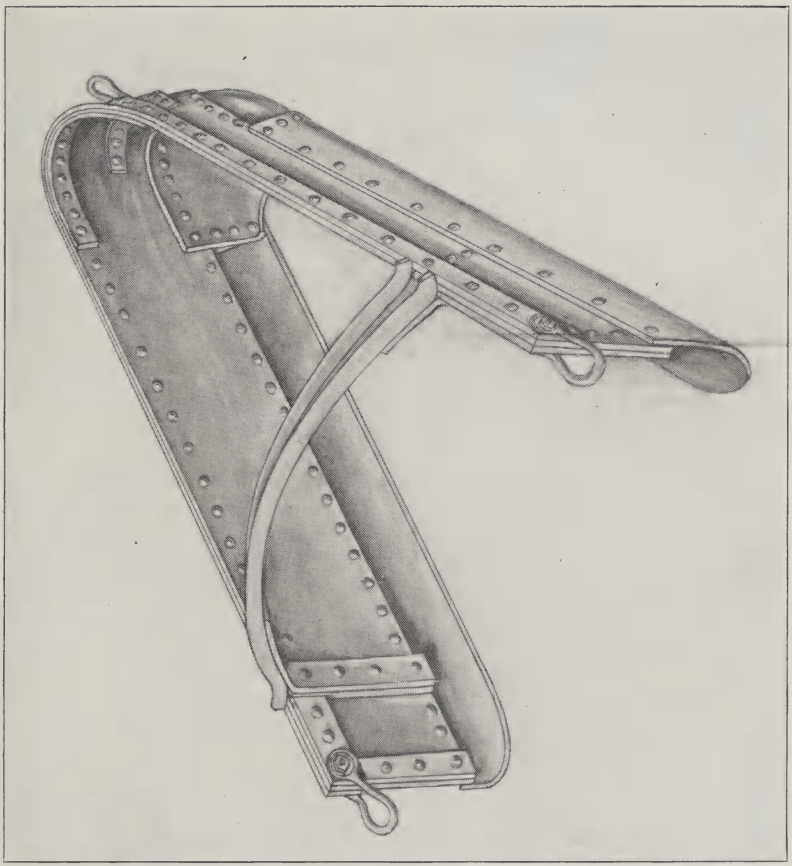


Figure 54—Perspective View of Scraper.

A perspective view of the scraper is shown in Fig. 54. In shape, it is similar to the old fashioned snow plow, but it does its work with the wide end foremost. It is built up from steel plates, the bottom plate on the sides being slightly curved inward so as to scoop the coal. The sides are braced with a piece of channel iron. Three sizes are made.

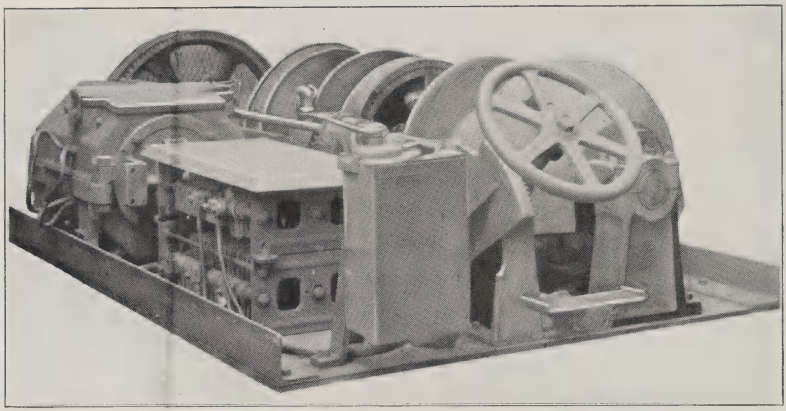


Figure 55—"Pneumelectric" Electrically Driven Two Drum Hoist

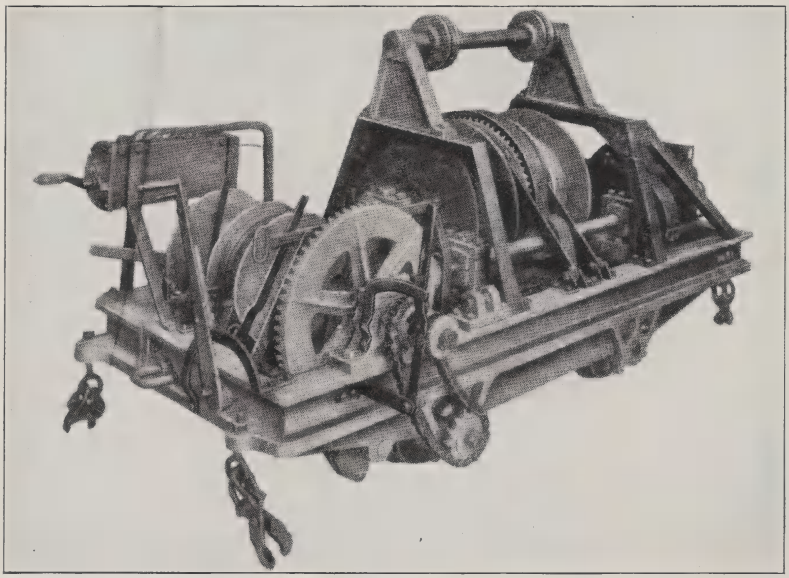


Figure 56—Lidgewood Electrically Driven Portable Four Drum Hoist.

The hoist operating the scoop is either stationary or portable; the stationary hoist has two drums, Fig. 55, and the portable hoist four drums, Fig. 56. The portable hoist is mounted on a self-propelled truck. Two of the drums are used to haul the scraper backward and forward, one drum carrying the main rope and the other drum the tail rope. The two drums on the end are used to pull empty and loaded cars in place.

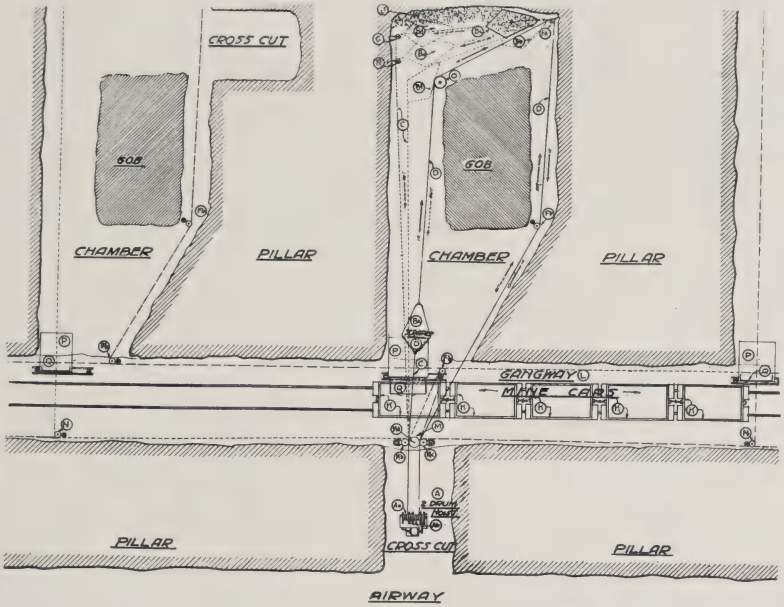


Figure 57—General Layout of Two Drum Hoist and Scraper Line.

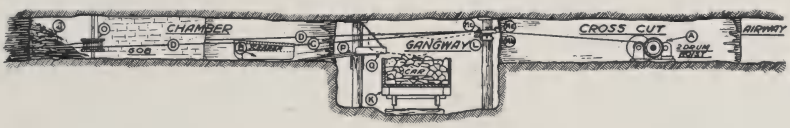


Figure 58—Section of Two Drum Hoist Through Chamber and Gangway.

Fig. 57 is a plan showing the arrangement for a two-drum hoist, and Fig. 58 is a longitudinal view. The hoist is set in a cross-cut between the gangway and airway for safety, and from this point is able to handle the scraper in at least five chambers. In the figure the hoist is scraping coal from the chamber opposite the cross-cut. In operation with the scraper at the car, the tail rope drum is started and pulls the scraper to the face of the chamber, the tail rope pulley being located at the far end of the chamber. When the scraper reaches the desired point at the face, the engineer is given a signal

to stop. The scraper man then shifts the scraper to the loose coal; the main rope drum is started and the scraper fills itself with coal, the operation being continuous until the scraper discharges its load in the mine car.

The direction of the travel of the loaded scraper is regulated by snatch blocks fastened to the rib or to the jacks. It requires from four to seven scraper loads to fill a mine car, depending upon the size of car.

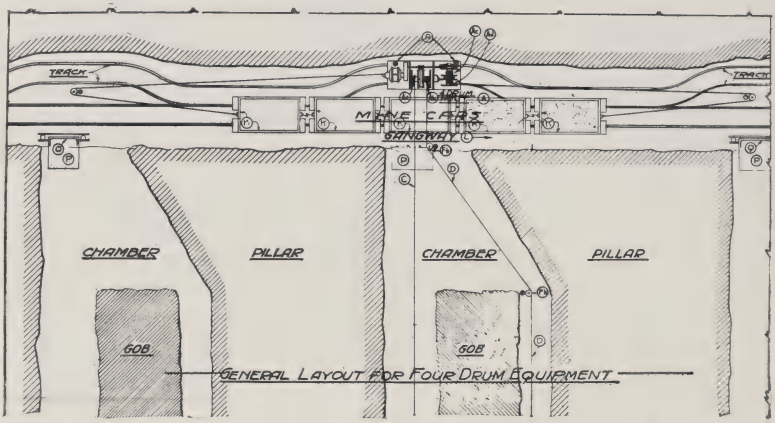


Figure 59—Cross Section of Four Drum Hoist, Chamber and Gangway.

A plan of the arrangement for the four-drum or portable hoist is shown in Fig. 59. The manipulation of the scraper is practically the same as the two-drum hoist. The arrangements of the tracks, however, is different. It will be noted that in front of each chamber there is a double track, and between the chambers there are only three rails. This arrangement of tracks saves the cutting of rock both for height and width. The ropes and pulleys for the manipulation of the light and loaded cars are plainly shown. Fig. 60 shows a longitudinal section of the chamber and a cross-section of the gangway, mine car and hoist.

At "O" is shown a large wood wheel that changes the direction of the scraper when going up the chamber.

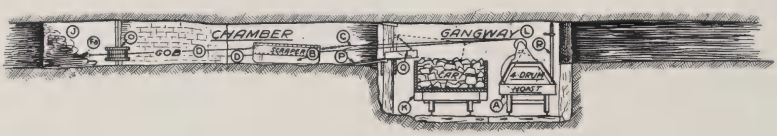


Figure 60—General Layout for Four Drum Hoist.

CHAPTER 5

METHODS OF OPERATION

Methods of operation may be discussed under three heads, viz:

(a) Headings
(b) Chambers
(c) Long-wall

In anthracite mining there are so many different conditions to meet that it necessarily follows that there will be a great many different methods used to meet these conditions. Not all areas in the mines are suitable for machine mining. This is due, in a measure, to the fact that when first laying out the plan of operation, the possibilities of machine mining were not taken into consideration. The conditions that tend to make the mining machine eminently successful are: ample power, a bed lying practically level, with a good roof, a hard smooth bottom, and wide places free from rolls. On the other hand, the machine will not be a success when a bed pitches over 15 degrees in chamber work, and contains an abnormal amount of sulphur balls or other hard impurities, when faulty rock benches come in the bottom, or the bottom is very irregular. Much the same remarks are applicable to the conveyor, but the scraper being much more flexible, can be used under almost any conditions.

(a) Headings

No matter what method of deveolpment is used in mining, it is necessary to maintain headings, or gangways, and airways, and one of the heaviest items of expense in mining is driving these main arteries. It is a common practice to drive headings on a water level, that is, the heading is driven in the coal at such a pitch or grade that the water flows toward the mine opening. This is apt to make a crooked heading and adds considerably to the length. To make a straight heading under conditions of this kind would require the cutting of so much rock that the mining machine would be useless. Owing to the narrowness of headings, which are driven from 12 to 14 feet wide, the short-wall machine is not as efficient as in chamber or long-wall work. Even when the heading is driven straight, it takes just as much time to unload, making the sumping cut, and reload in a heading as in a chamber, and the undercut is not more than half as long, while the work requires much more attention and consequently takes more time. In all probability the best machine for heading work is the arc wall or the straight face machine as described on pages 10 to 13, with the preference given to the straight face machine. The method of operating these machines is shown in Figs. 6 and 8. This machine will cut a heading just as straight as the track is laid. If the tracks are on a curve in a crooked heading, the machine will cut on a curve and maintain a normal face. Furthermore, the machine is self-contained and is

ready for cutting the moment it reaches the face, thereby saving the time of unloading and loading as would be the case in a short-wall machine.

One objection of this type of machine is that the tracks must be kept very close to the face. This sometimes would cause delays, especially where there is heavy bottom rock to be removed.

(b) Chambers

Practically all of the anthracite mines are worked by chambers opened from headings. In the bituminous mines this method is known as "room and pillar" mining. Chambers are driven from 20 to 40 feet wide with a pillar between each chamber from 16 to 50 feet through. These measurements depend upon the depth of bed under the surface, the nature of the roof, and sometimes the strata underlying the bed. The wider the chamber, the greater will be the efficiency of the mining machine.

Figure 61—Typical Plan of an Anthracite Machine Mining Place.

Fig. 61 shows a plan of the method of opening chambers off headings.

The cycle of operations in undercutting chambers might be classified as follows:

(1) Unloading and moving machine to the face.
(2) Sumping the cutter arm under the coal.
(3) Undercutting across the face.
(4) Moving out and loading.
(5) Traveling to the next chamber.

The percentage of the total time consumed in cutting coal, moving machine, and changing bits, under normal working conditions would be approximately as follows:

Cutting coal	44%
Moving machine	36%
Changing bits	20%

In conveyor or scraper chambers, the mining machine moves itself from the heading to the working face and when the chambers get to such a length that cross-cuts are opened, the mining machine is taken to the next chamber through the nearest cross-cut, saving considerable travel.

In order to more clearly show the actual operation of the mining machine, the following illustrations have been taken from photographs made in the mines of a short-wall or continuous cutting machine. The complete cycle of operations is shown in cutting one chamber from the time the machine is being unloaded from the truck until it is on the heading going to another chamber on a self-propelled truck. Beside the figure is shown a plan view of the operation. Then follows the illustration showing the drillers, miners charging the holes fired by electric battery and the results of shot. The chamber in the illustration is 30 feet wide with a thickness of bed of about four feet. The undercut is six feet and thickness of kerf 5¾ inches.

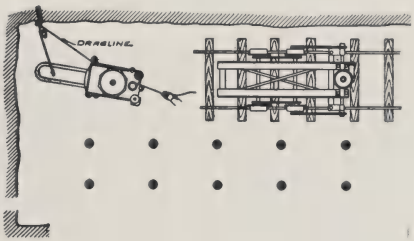


Figure 62—Unloading from Truck.

Fig. 62. Shows the machine leaving the truck with the machine runner at the driving mechanism, and the machine helper resting his hand on the jack to the bottom of which the feed rope has been fastened. The machine runner starts the feed drum and the feed rope drags the machine off the truck with no laborious work of either the machine runner or machine helper.

Fig. 63 shows the machine in a position ready to sump in the right hand corner of the chamber with the machine helper standing close to the forward jack that is set to drag the jib or cutter arm under the coal. The jack to the right of the figure is known as the

Figure 63—Ready to Sump.

tail jack and is used to anchor the tail rope which controls the rear end of the machine while sumping cut is being made. All of the operations to this point have been made on fast feed, there being two feeds to the machine, one propelling or moving the machine and the other for cutting. The ratio of the difference in the feeds is about twelve to one.

Figure 64—Sumped.

Fig. 64 shows the cutter bar entirely under the coal a distance of six feet. Up to this point the operation has consumed about twelve minutes. When the sumping is complete, the jacks are re-arranged, the tail jack is set up two or three feet from the face near the right hand rib. The top of the jack is shown in line with the machine runner's head. The feed rope is unwound from the drum and taken to the left hand rib near the face and anchored. The machine is now ready to begin the cut across the face.

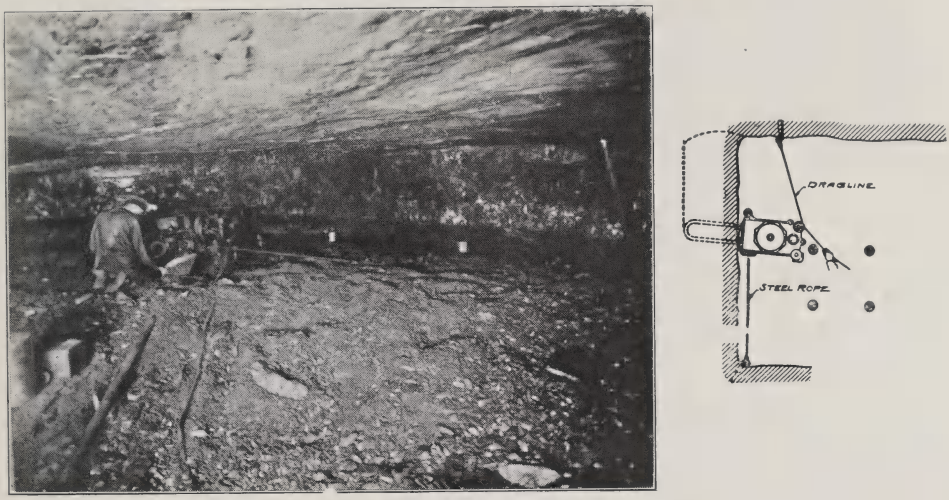


Figure 65—Machine Half Way Across Chamber.

Fig. 65 shows the machine in the center of the chamber. The machine helper is shoveling the cuttings away from the machine, and the machine runner is closely observing the working of the machine. It will be noted that the jack has not been moved since commencing the cut, and unless sulphur or some hard material is in the way of the cutter, this jack stays in place until the machine gets to the left hand corner. The two wooden wedges in the kerf to the right of the machine have been placed there to keep the bench immediately above, from falling and thus blocking the undercut. These wedges will be removed before setting off the shots.

Fig. 66 shows the machine in the left hand corner of the room with the undercut practically completed, the cut showing very clearly. When the machine approaches the left rib the machine runner watches closely to keep his width of chamber correct, and the rib properly aligned. He does this by the way he draws the

Figure 66—Machine in Left-Hand Corner of Chamber.

machine from the undercut. If the chamber were somewhat narrow the cutter bar would be swung to the left by holding back the rear end of the machine with the tail jack. The plan at left of picture shows the operation of widening the chamber.

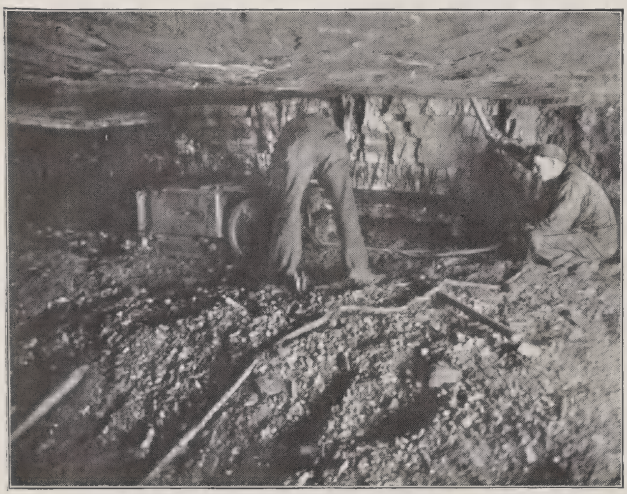


Figure 67—Machine Returning to Truck After Completing Cut

Fig. 67 shows the machine being withdrawn from the completed cut preparatory to reloading on the truck. When dragging the machine around the place the cutter chain does not revolve, the feed drum working independently of the cutter chain mechanism.

The position of the machine as shown in the figure is about parallel with the face. The machine helper has placed the jack in such a position that the machine will drag itself in a position to be loaded on the truck. All of the above operations have been performed with no hard labor on the part of the operatives.

The length of time consumed from the time the machine left the heading until it returned to the heading was fifty minutes.

Figure 68—Machine on Gangway Going to Next Chamber.

Fig. 68 shows the machine traveling along the gangway or main road to the next chamber. The machine moves from working place to working place on a self-propelled truck, actuated by direct transmission from the motor of the machine itself to the track wheels of the truck. On this machine is a chain guard which slides under the machine when sumping. In the figure the machine helper is sitting directly over the end of the chain guard. The machine runner makes connection with the trolley wire by what might be termed a "hand trolley pole." This device is well insulated so that there is no danger to the operative.

It very often happens when the machine is making an undercut that the bits will come in contact with a deposit of sulphur or some other very hard impurity in the bed, or the bits may be dulled before the cut is completed, necessitating the withdrawal of the machine from the undercut in order to change and reset the bits. The following figures illustrate the methods used.

Fig. 69 shows the method of removing a deposit of sulphur, (a) shows the first position of the machine by dotted line. In order to place the machine in this position the drag line is slackened and the feed line pulls the machine ahead, thus cutting partly around the obstruction. The drag line is then tightened and drags the

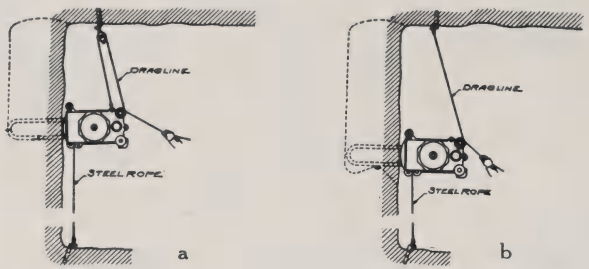


Figure 69—Method of Cutting Around a Sulphur Ball.

head of the machine, with the assistance of the feed line, gradually into the position shown by solid line, thus cutting partly around the other side of obstruction. The machine is then brought to a normal position as shown in (b) and the obstruction is jerked out.

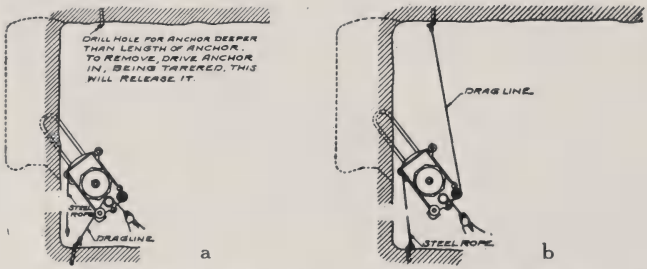

DRILL HOLE FOR ANCHOR DEEPER THAN LENGTH OF ANCHOR. TO REMOVE, DRIVE ANCHOR IN, BEING TAPERED. THIS WILL RELEASE IT.
STEEL ROPE
DRAGLINE
a
DRAG LINE
STEEL ROPE
b

Figure 70—Method Used in Removing Machines to Reset Bits.

Fig. 70 shows the method used in removing the machine from the undercut in order to renew the bits, (a) shows the machine with the drag line on the left side of the head of the machine pulling the cutter arm free from the kerf. (b) Shows the machine returning to cutting position after the bits have been renewed. The drag line is fastened to the righthand rib and the feed line held stationary.

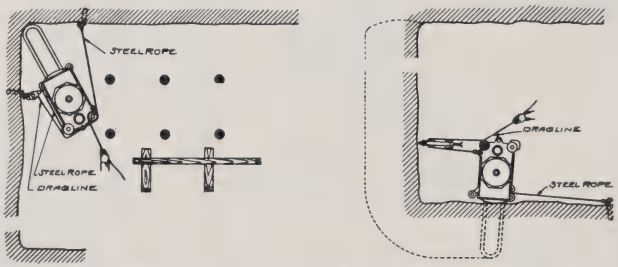


Figure 71—(a) Method of Sumping When Props Are Close to Face.
(b) Method of Widening Chamber.

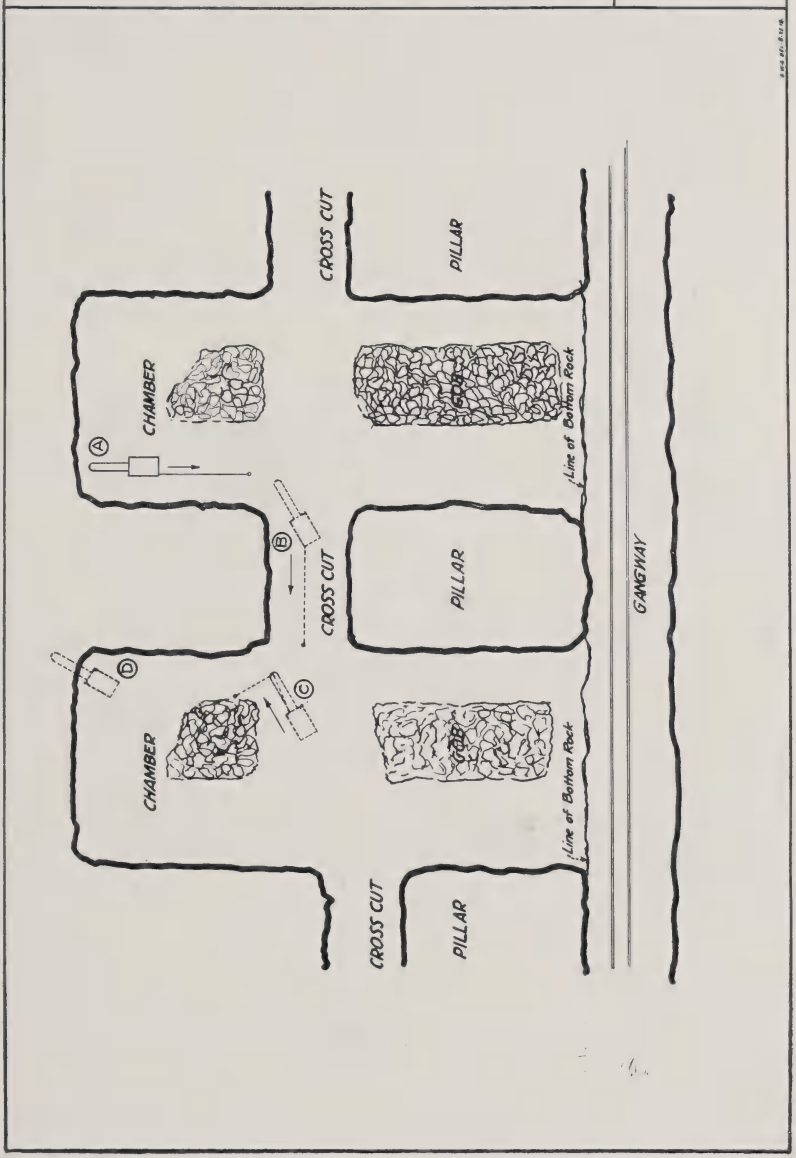
Fig. 71 (a) shows the manipulation of the machine for sumping when props are set close to the face; (b) shows machine widening a chamber.

The use of scraper equipments and the elimination of any kind of roadway in the chamber made it necessary to devise some new

way of handling the mining machine when changing from one chamber to another. It is obvious that the task of moving up to scoop platform level at the gangway, or lowering off at that point would be too toilsome and time consuming to be practical.

The following system was finally worked out: the chambers set aside for scraper work are driven a distance of about 35 feet.

METHOD OF MOVING MINING MACHINE WITHOUT TRUCK. FIG 72



Cross-cuts are driven between all of them. The machine is placed in the first one and thereafter all change from chamber to chamber is made through cross-cuts. Fig. 72 shows a typical case. At "A" the machine has just been unsumped and a jack set down the chamber. The machine is pulled back to "B," then over to "C," then to "D," where it is sumped in and a new cut started.

After the undercut has been completed, the jackhammer men drill the holes. The holes are started about 18 inches below the roof and the drills are placed at such an angle that when the drill hole is in six feet, the end of the hole will be from four to six inches below the roof. As a general rule, there will be four holes in a thirty-foot chamber. The holes in either corner of the chamber are placed about two feet from the rib. The time consumed in drilling one hole six feet deep is about four minutes. The total time for drilling the four holes and moving drill to next chamber is about forty minutes. Fig. 73 shows the drill hole in the left hand corner of chamber. The trestle on which the machine rests gives direction to the drill and also relieves the operatives. Fig. 74. In this figure the jackhammer men are drilling the bottom rock. The rock in this place is about two feet thick.

Figure 73—Drilling.

The holes are started as close to the bottom as possible, the drill resting on a one inch board, which is given a slight elevation at the end by placing a block under the board, as shown in the figure. The jackhammer man sits on the board and holds his feet against the hammer, thus guiding and holding it in place. At the face the trestle is shown that was used to hold the jackhammer.

Figure 74—Jackhammer Men Drilling Bottom Rock.

After the holes are drilled, the machine miner and his helper charge the holes which consists of cleaning out the drill hole, placing the charge, tamping and wiring. From 12 to 15 inches of blasting powder is used in each hole, the amount of explosive depending upon the structure of the bed. Before the charge is placed in the drill hole, the miner primes the cartridge with an electric squib. The squibs have two electric wires fastened to them from four to eight feet long. These wires are in turn attached to the lead wire. Fig. 75 shows the miner and his helper charging one of the holes with explosives preparatory to blasting the coal. Fig. 76. The four drill holes have been connected with electric wire, and then to the battery. The figure shows the miner in a safe place pressing down the lever that fires the shot. Fig. 77 shows the result of the shot. The coal has been brought down in large pieces, so there will be very little waste. The coal in this section is loaded by hand. If this same chamber had been "shot off the solid," it would have required from 10 to 13 drill holes with 18 to 30 inches of powder in each hole. With this amount of powder the coal would have been shattered and partly blown in the gob.

Gathering and loading coal by means of the scraper is probably one of the most practical and simple methods used. The scraper loads itself and does not require hard labor on the part of the operatives.

Figure 75—Charging Holes.

Figure 76—Miner in Safe Place with Electric Battery Firing Shot.

Figure 77—Result of the Shot.

Fig. 78 shows the scraper partly loaded near the face of the chamber. The man with his hands on the back end of the scraper is standing over the tail rope which is used to haul the scraper back after it has deposited its load in the mine car. On the left is shown a large wooden buffer wheel that changes the direction of the rope pulling the empty scraper. It will be noted in the foreground of the figure that the scraper cleans the floor very well, so that there is not much shoveling.

Figure 78—Scraper Starting from Face of Chamber.

Fig. 79 shows the scraper going down the chamber entirely loaded. From the last figure to the point where we see the scraper now, it has gathered sufficient coal to have really placed topping on itself. Note the clean appearance of the chamber. The tail rope is seen traveling around the large wooden wheel.

Figure 79—Scraper Going Down Chamber.

Fig. 80 shows the scraper unloading into the mine car. Owing to the fact that the scraper has no bottom, the coal begins to drop into the car as soon as the front end of the scraper reaches the end

Figure 80—Scraper Discharging Its Load in Mine Car.

of the apron. The clevis block fastened to the roof and the bridel chain on the front end of the scraper are distinctly seen, also the tail rope fastened on the rear of the scraper. Some idea of the height of bed may be gained by the man sitting on the floor of bed near the left hand side of the figure.

Fig. 81. This figure is intended to show the adjustable apron over the car. The apron is made to raise and lower. When the car is empty the apron is lowered, thus preventing the coal from breaking; as the car is loaded the apron is raised. The snatch block to the right of car is plainly seen. This device changes the direction of the haulage rope. The small wires seen near roof are the electrical signal wires connecting the face of the chamber with the engine and the loader at the car.

Figure 81—Adjustable Apron.

Fig. 82. In this figure the apron is shown raised to the highest point and the scraper is placing the last load on the car. The man to the right arranges the lumps of coal on top of the car so that they will not fall from the car when being transported to the breaker. The loader has his thumb on the push button to signal the engineer when the scraper has reached the right point over the car.

The portable hoist carries four drums and is operated by an electric motor. In operation it is located directly in front of the loading apron, hauling the scraper line in the same way as did the stationary drums. Two of the drums on this hoist are used to shift

Figure 82—Putting Last Scraper Load on Mine Car.

the loaded and empty cars. In this way most any number of cars may be loaded without depending on mules or any other motive power. When the full trip is loaded, it is hauled to the foot of the shaft by an electric locomotive.

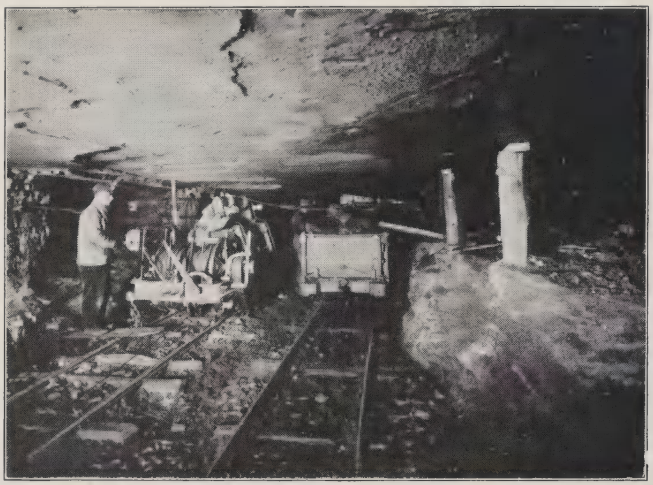


Figure 83—Scraper Operated by Four Drum Hoist.

The amount of power consumed varies considerably, due to a number of factors. The most important are, the nature of the material cut, condition of floor of bed, pitch of bed and the machine runner.

The length of cutter arm and width of kerf have an important bearing on power consumption. Under average cutting conditions (with a cutter arm six feet long and a 5¾ inch kerf) .06 K.W. hours per square foot undercut would be consumed. In other words, it would require 7.8 K.W. hours to undercut a depth of six feet a chamber 30 feet wide. Added to this is the power consumed in transporting the machine from place to place, unloading, handling the machine at face, and loading, probably making a total consumption of power for the full cycle of undercutting a chamber, 12 to 15 K.W.

The power consumed in operating scrapers and conveyors depends on their size and length and the amount of coal handled some place within the limits of 8 to 20 H.P.

The horse-power required for the following machines would be approximately:

Coal Cutter	20 to 40
Scrapers	8 to 15
Portable Air Compressors	12 to 24

To obtain the best efficiency from a mining machine, it should be worked on a long face. This not only applies to the long-wall machine, but also the short-wall, or continuous cutter.

Jackhammer Mining and Scraper Loading

It has been found an advantage in the face where no electric current is available for mining machines, to use jackhammers to blow the coal off the solid and load by means of the scraper. In this work a great deal depends upon the miner so that the holes are drilled to the best advantage and the least amount of power used. The miner drills the whole face of the chamber as a rule, taking from 8 to 20 6-foot holes, depending on the nature of the coal and cleavage. The greatest difficulty encountered in this work in thin veins is the firing where squib or instantaneous electric exploders are used, every hole or every two holes having to be fired separately, thus consuming a great deal of time. To overcome this difficulty, the following method was tried and found to work very satisfactorily. The face was drilled with 2 or 4 opening or cut holes (A) as shown in Fig. 84, and then the rest of the holes (B, C, D, E,) were drilled as relief holes.

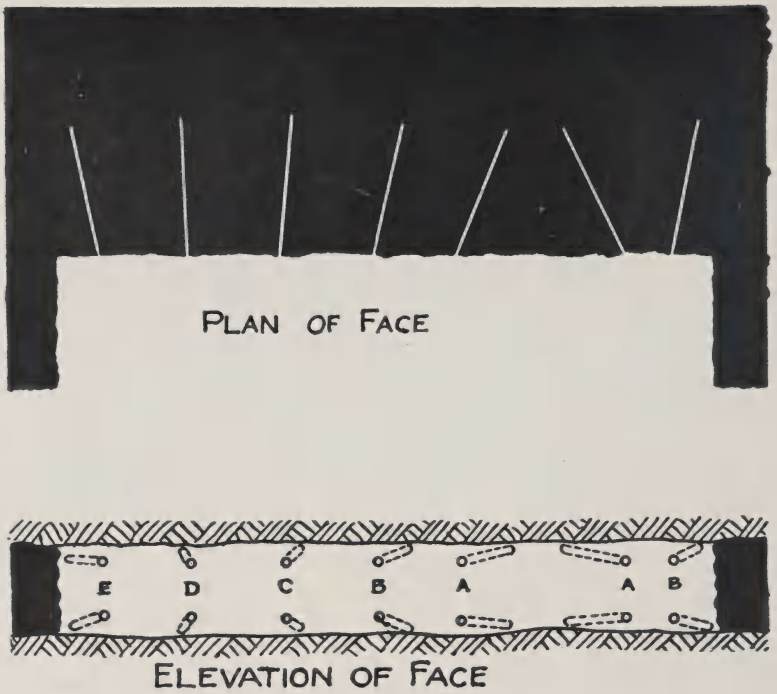


Figure 84.

Holes "A" were fired with instantaneous electric exploders and then holes B, C, D and E were charged, connected and fired by one pull of the battery using electric delay action exploders, each delay being six seconds. The exploders placed in holes "C" go off six seconds later, exploders placed in holes "D" six seconds behind "C," exploders placed in holes "E" six seconds behind "D." These exploders can be obtained from the Du Pont Company in six different delays, thus permitting seven delay holes or series of holes by using an instantaneous exploder and the six delays. By means of these exploders two sets of firing will explode an ordinary chamber face and only necessitate the miner going back once in the smoke, reducing the firing time 70% and greatly increasing the efficiency of the operation.

In jackhammer mining for scraper loading, the opening hole should be placed in line with the scraper roadway or chuteway wherever possible as these holes being fired first, the relieving holes will naturally throw the coal toward this opening and then make the scraper work easier and have less tendency to blow coal in the gob.

The method of loading out coal thus cut is practically the same as described in machine mining.

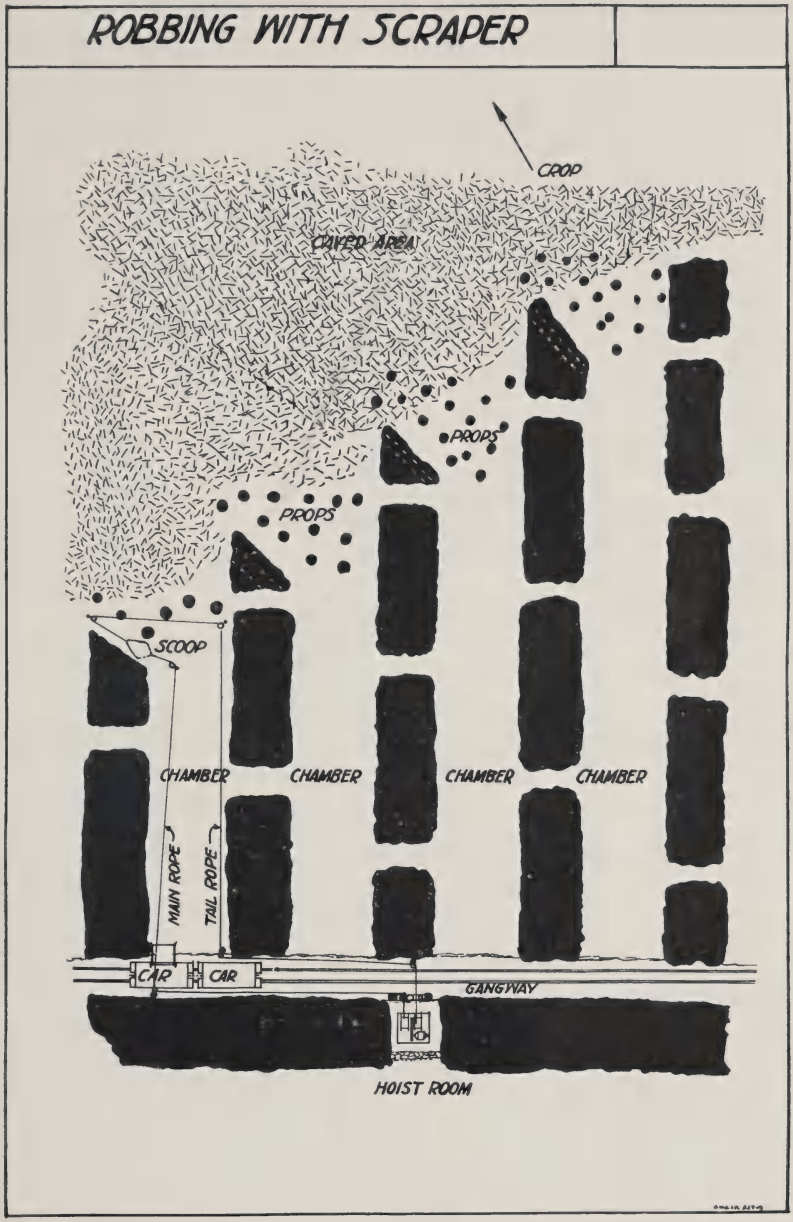

ROBBING WITH SCRAPER
CROP
CAVED AREA
PROPS
PROPS
SCOOP
CHAMBER
CHAMBER
CHAMBER
CHAMBER
MAIN ROPE
TAIL ROPE
CAR
CAR
GANGWAY
HOIST ROOM

Figure 85.

The scraper is being used in pillar robbing in thin veins, the only difference as compared to hand robbing is to keep the robbing of each pillar at any angle, as shown in Fig. 85, wherever possible so as the scoop can get along the face of the pillar more readily than if the pillar is cut off square, and also to keep the props if possible six to seven feet from the face of the pillar in order to allow the scoop to get in along the face of the pillar.

(c) Long-wall

There are two general systems of long-wall mining; long-wall advancing and long-wall retreating. In long-wall advancing, the face is started near the bottom of the shaft, or other mine opening, and advances toward the boundary lines, or out-cropping of the property, the roads being maintained by pack-walls on either side. By this method the mines are opened rapidly.

In long-wall retreating, narrow headings are driven to the boundary lines of the property and the long-wall faces are started from these points, the coal being mined out completely as the face approaches the mine opening. In either of the systems long faces will be obtained, making an ideal condition for mining machines. The method generally used in anthracite mining might be called a long-wall block system, the blocks being started at almost any convenient place in the mines, preferably near the boundary of the property.

There are a number of conditions to be taken into consideration before a method of obtaining a long face can be adopted in any bed. The nature of the roof, the nature of the overlying strata for at least fifty feet above the bed, overlying beds, the nearness of the overlying beds, the thickness of the coal, the nature of the coal, strata immediately below the bed, and the pitch and contour of the bed should be taken into consideration. Another important point to be considered is the organization of the operatives. Long-wall mining should not be undertaken unless a few of the operatives are practical long-wall miners.

Fig. 86 shows the plan of a system of mining somewhat similar to the chamber and pillar mining. The gangways are driven 400 to 500 feet apart, with sufficient width so that all impurities in the bed, and the bottom rock, may be packed alongside the road, leaving sufficient space between the back of wall and rib to allow a passage-way for the air.

From each gangway narrow places are driven in line until they meet near the center between the gangways. These narrow places are numbered 1 to 7 and are generally driven by three shifts per 24 hours day. The coal is moved either in buggies or by conveyors. Cross-cuts are driven between these narrow places for ventilation.

Fig. 87 shows a plan of working a long-wall face in which most of the coal is taken out. The airway is driven as a dog hole, and the coal is taken through the cross-cuts to the gangway. The gangway is driven narrow.

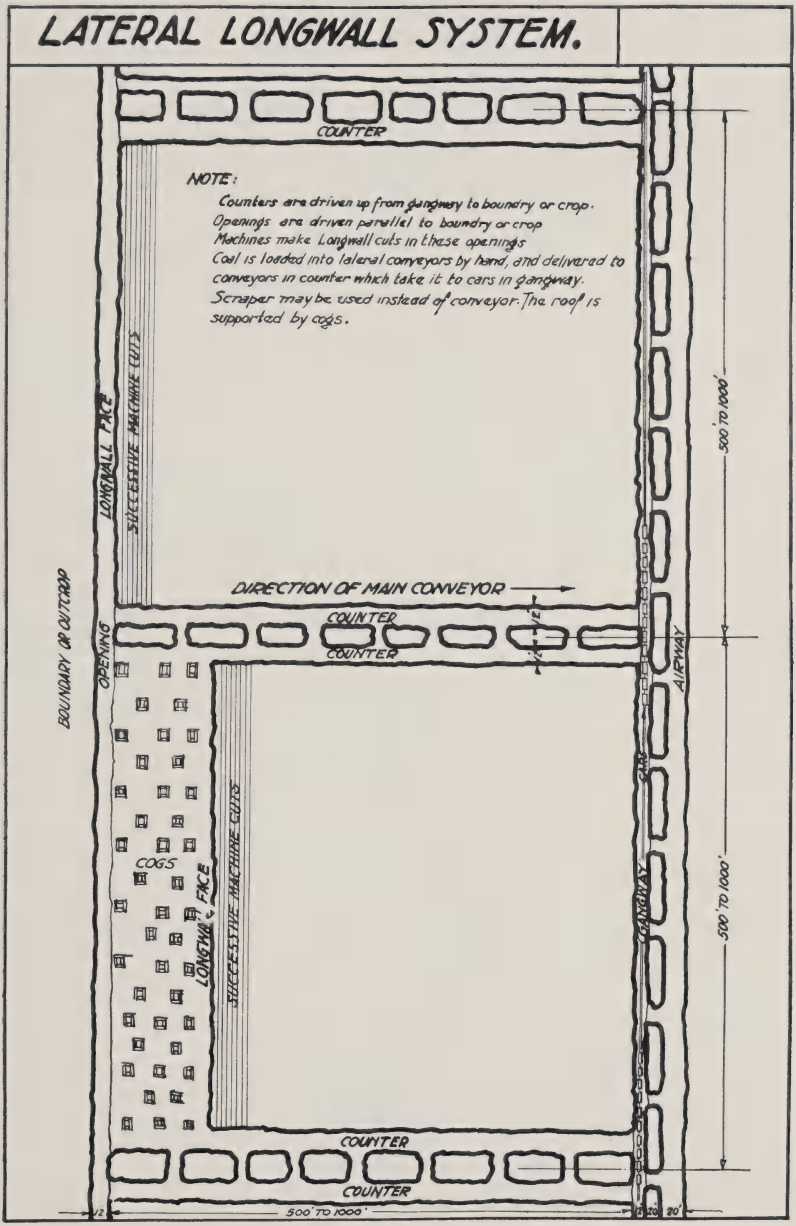


Figure 88.

The first openings are made in the block by driving places 12 feet wide, these places being cut by machine and the coal loaded out by means of buggies or conveyor or scraper. As the coal is undercut and removed, cogs are built from 20 to 30 feet on centers in the direction of the cut and from 12 to 20 feet on centers at right angles to the cut, the cogs being staggered in adjacent rows. For blasting, holes are drilled from 15 to 20 feet apart.

Fig. 88 is a plan of working that approaches Long-wall Mining. In this method, blocks may be opened at any place in the mines where there are no overlying beds, preferably, however, near the boundaries or outcrop.

Counter headings are driven from the main heading at such a point that the first openings at the face of counter heading will give a long face on either side. In these first openings lateral conveyors are installed which deliver the coal to the main conveyor in the counter heading. This in turn loads the coal on the mine car in the gangway. All of the coal is removed, including the pillars on the counter.

Fig. 89 shows another method of long-wall machine mining.

A pillar was left along the main heading and then each chamber was widened out to meet the next chamber and hence advancing long-wall face was formed and carried forward, the rock cut in the chamber roadway was used for pack. At the line A. B. very bad roof was struck and it was found to be an advantage to form a chamber and leave good pillar to strengthen the roof. After going about 100 feet, the roof became good again and the chambers were once more connected making a long-wall face, which was carried to the crop, the pillars left in were then robbed out.

The vein was 32 inches in thickness and fairly level. The coal was undercut by a machine on a 1000 foot face. The cars were kept up to the face in the chamber, rock and coal loaded by hand, each pair of loaders taking half the distance between the roads to load.

A good system of long-wall which has been adopted at the Hudson Coal Company's Collieries is shown in Fig. 90. Gangways are first driven about 200 feet apart. A chamber is started off the lower gangway. This chamber is driven up until it meets the other gangway. As the chamber is being driven a line of break props is placed which causes a break in the roof, and timber cogs are built in. The object of the cogs is to take the roof as it gradually settles and ease the pressure down on the rock walls built as the long-wall advances. The long-wall face is started by making machine cuts down the rib of the chamber. After the long-wall face is started, the upper gangway is carried along as a part of the long-wall advance. The lower gangway must be driven separately to provide room for cars.

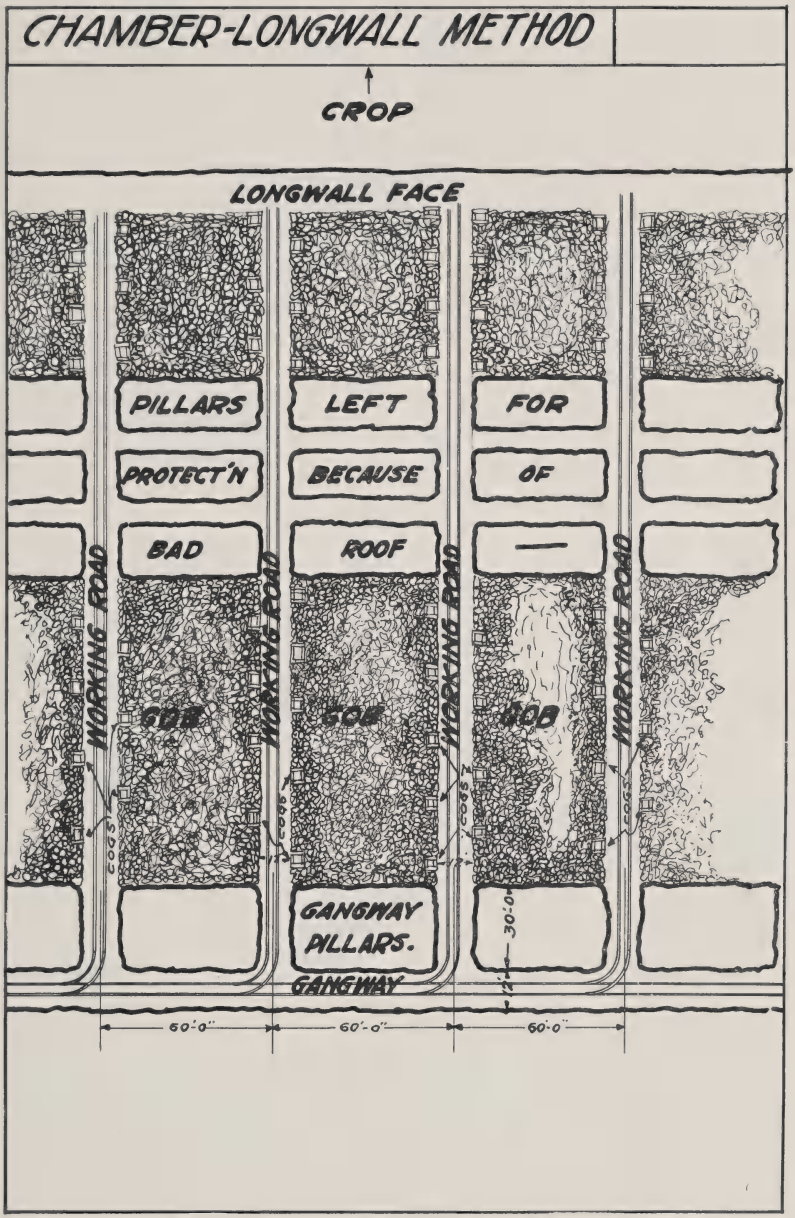

CHAMBER-LONGWALL METHOD
CROP
LONGWALL FACE
PILLARS
LEFT
FOR
PROTECT'N
BECAUSE
OF
BAD
ROOF
—
WORKING ROAD
WORKING ROAD
WORKING ROAD
WORKING ROAD
GOB
GOB
GOB
COALS
COALS
COALS
COALS
GANGWAY
PILLARS.
GANGWAY
30'-0"
60'-0"
60'-0"
60'-0"

Figure 89.

BEFORE CAVING HAS OCCURRED

AFTER CAVING HAS OCCURRED
SHOWING ARCHING ACTION OVER STONE ROADS

SECTION LOOKING TOWARDS LONGWALL FACE

ORIGINAL CHAMBER

STONE ROAD FORMED - SHOWING TOP TAKEN DOWN

SECTION THROUGH STONE ROAD

N.H. RAIBER '9

DEVELOPMENT OF LONGWALL OPERATION
Gangway carried forward as part of Longwall
Longwall Face
13'
8'
9'
11'
40'
START OF CHAMBER
CHAMBER COMPLETED

Figure 90.

Figure 91—Scoop and Loading Apron of a Long-Wall Face. The Prop at the Top of the Ladder Gives a Good Idea of the Thickness of Coal Worked.

Figure 92—Timber Cogs Along Gangway. Long-Wall Operation.

Figure 93—View at Long-Wall Face.

Figure 94—View at Long-Wall Face Showing Rock Pack Wall.

Three stone roads are made by taking down top rock. The object of these stone roads is to provide rock for the stone pack walls to take the roof pressure and to provide ready and safe roads of access to the long-wall face. Loading is done by scraper. In order to show the thin beds that this system of long-wall is applicable to, reference is made to Figs. 91, 92, 93 and 94.

Conveyors.

Figure 95—Head of Conveyor Line Over Loaded Mine Car.

Fig. 95 shows the head of the conveyor line with a mine car under the head practically loaded with coal. Owing to the thinness of the bed, it becomes necessary to cut several feet of bottom rock in the gangway in order to give sufficient clearance for the car under the head of the conveyor, when the car is topped with coal. In some cases the roof is taken down directly over the head of conveyor in order to obtain height. In such cases it is not necessary to cut bottom rock.

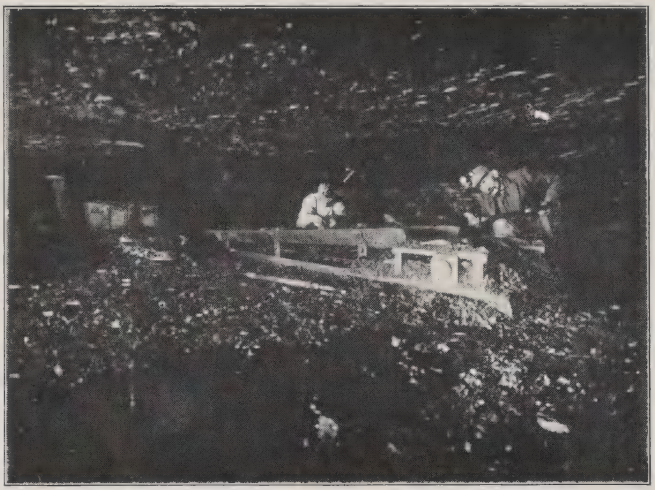


Figure 96—Conveyor Trough Near Face of Chamber.

Fig. 96 shows the end of the conveyor near the face of the chamber and a part of the conveyor trough. The top of the conveyors is built so there will be sufficient clearance between the top of the trough and roof to allow the coal to be shoveled into the conveyor. In the figure, two laborers are loading the conveyor. Some idea of the height of the bed may be gathered from the stooping position of the laborers. To the left of the conveyor line is shown a mining machine.

With conveyors, where men have to load into the conveyors, each man has a certain distance of face to load out. Work usually commences, after the coal is blown down, by breaking it at one end of the distance to be covered, and from there on loading out continuously until completed. Generally this takes eight hours on a two to three hundred foot face, allowing for various time losses due to want of cars, stoppage of power and other causes.

Shifting of the conveyor is done at night, and with conveyors which stretch the full length of the face, the machine can be either shifted in sections or swung laterally over. Some conveyors are readily taken apart in eight to twelve foot sections, and these sections are shoved bodily over to the new position, timber being cut and reset when necessary. The motor end is taken first and then section by section until the top is reached, where the tightening arrangement comes into play to take up the slack. The other method consists of pinching and pushing over the bottom portion of the conveyor without uncoupling and following the curve so created up to the top. This process is repeated until the conveyor reaches its new line. With conveyors which are shorter than the face and usually run by a rope, this rope is used to haul the conveyor through the timber into its new line.

CHAPTER 5

ORGANIZATION

Arrangement of Operations

Owing to the fact that machine mining in the anthracite region was only started a little more than nine years ago, and then only in a small way, it has been a problem to obtain practical men along this line of work. It is true that good practical men may be found in any anthracite mine, men who can turn their hands to almost any kind of work along mechanical lines, men who are willing and anxious to learn; but no matter how bright or how willing, it takes time to develop them along a line of work that is entirely strange to them. As a general rule, the Operator has thought it to the best interest of his employes and himself to train the men in his mine to machine mining, rather than to go on the outside for help. The matter of getting efficient organizations to handle the machine mining sections has generally been difficult.

The machine boss has a number of machines under his supervision. He takes general charge of the machines and sees that they are properly worked and maintained. If possible, the machine boss should inspect each machine daily, and if this is impossible, owing to the number of machines or to the machines being distributed over a large area, he should designate some competent person or persons, preferably the machine runner, to make these inspections. The machine runner in the first place looks after the safety of the working places, sees that props are set, locates the places for drilling holes, charges and fires them, sees that the coal is properly loaded and the rock properly stored. The machine miner's laborers assist the miner in blasting, by setting props, shifting rock and gob and doing other work at the direction of the miner. The machine runner by the aid of his helper operates the machines, and is responsible for its proper working. He should be familiar with every part, and be able to manipulate its movement, whether undercutting or being shifted, with the least possible delay.

After the coal is shot down, it is loaded in mine cars, and it is the duty of the loaders to see that the car is loaded with clean coal. Where mechanical loading is done, the organization is separate from the mining machine force, with the exception of the machine miner, who looks after the safety of the men. In scraper mining, the scraper boss takes general charge of the work, the scraper engineer operates the drums, and the scraper man operates the scraper at the working face.

Care of Machines

Most of the equipment connected with machine mining is costly equipment, and should be given care, not only on the part of the operator of the machine, but every employe connected with this

branch of mining; there would then be more efficiency and not so much time lost on account of machine not being up to standard or breakdowns of some part of the equipment. The length of time a machine will be fit for service depends largely on the care it receives.

Machines should be inspected at least once a week by a competent repair man who understands the mechanical and electrical details of the machine. The machine runner should inspect his machine each day as to the operating details. The weekly inspection by repairmen should cover the following points:

(1) Examine the controller and see that all contacts make good connections and are in good condition.

(2) Examine the motor, seeing the commutator is clean, brushes working free, all electrical connections tight, motor bearing should be examined, examine armature to see there are no loose binding wires, see spacing is corrected between pole pieces and armature, and see that motor is cleaned.

(3) On the resistance examine connections seeing they are tight, and that no grids are broken.

(4) On the mechanical end, examine the friction clutch and see that it is properly oiled. Also examine bearings, and make sure that all the lubrication system is clean and working all right. Examine cutter bar to see that gibs are not badly worn so as not to allow the chain to drop out. Cutter chain should be examined for broken set screw picks, or blocks which should be changed at once.

The machine runner should see each day before running his machine that:

(1) The cutter chain has proper tension.

(2) The bits are right gauge and in good condition, and that all the bits are in the chain.

(3) Be sure and oil all bearings at least twice a day and make sure oil is running all right.

In operating the machine, the runner should watch his cutter chain for tension, and should stop and examine his bits after cutting ten feet, and change any bits which are bad. If more than two bits in seven blocks need to be changed, machine should be pulled from under the cut and bits then changed. This will help to reduce many troubles we are now having with our machines, both mechanically and electrically. The runner should watch his cuttings carefully to see that he is not cutting into rock.

A book of instructions on care and operation is issued by the Machine Mining Companies, and each colliery using machines should have a book.

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